

DATE: APRIL 14, 2004

FROM: STEPHEN M. SMITH, DIRECTOR
OFFICE OF MANAGEMENT COMMUNICATIONS, ME-43

TO: DIRECTIVES POINTS OF CONTACT

SUBJECT: DRAFT DOE G 430.1-1X, *DOE Cost Estimating Guide—for Program and Project Management*

This is to notify you that the subject draft Guide has been posted in the “Draft” section of the DOE Directives Portal system for simultaneous use and coordination. The purpose of this Guide is to provide uniform guidance and best practices that describe the methods and procedures used in all programs and projects at DOE for preparing cost estimates.

Comments in the Guide are due June 15, 2004. Comments on Guides should not be designated “major” or “suggested,” they should be simply labeled as “comments.” Because Guides provide nonmandatory, supplemental information about acceptable methods for implementing requirements, comments supplied will be considered advisory in nature

The following procedures should be followed for the submission of comments:

Directives Points of Contact at Headquarters Organizations: Submit one set of consolidated comments to the originator of the Guide: David Treacy, ME-90, Room 4B-122, Forrestal, facsimile 202-586-3695; or Internet address: david.treacy@hq.doe.gov.

Send an additional copy of comments to Karen Alozie, ME-43, Room 4B-172, Forrestal, facsimile: 202- 586-1972; or Internet address: Karen.Alozie@hq.doe.gov.

Directives Points of Contact at Field Organizations: will submit consolidated comments to their appropriate lead program Secretarial Office. The package submitted by field organizations must include as an attachment the comments provided by contractors.

Contractors will submit comments directly to their appropriate Field Elements.

Questions concerning the content of the Guide should be directed to David Treacy, (202) 586-3151. Questions on the directives system should be directed to Karen Alozie at (202) 586-9852.

Attachment

COST ESTIMATING GUIDE FOR PROGRAM AND PROJECT MANAGEMENT



“Planning for Success!”

U.S. Department of Energy
Office of Management, Budget and Evaluation

FOREWORD

A current underlying theme within the government and a backdrop of the *President's Management Agenda* is to manage work effectively and efficiently. This theme, stated as a requirement, applies to all aspects of the Department of Energy (DOE). To meet this requirement, DOE must develop and maintain accurate, reasonable, verifiable, supportable, and up-to-date life-cycle cost estimates for all programs and projects.

The purpose of the *DOE Cost Estimating Guide for Program and Project Management (DOE Cost Estimating Guide)* is to provide uniform guidance and best practices that describe the methods and procedures used in all programs and projects at DOE for preparing cost estimates. This guidance is applicable to all phases of the Department's Acquisition Management System and real property life-cycle asset management activities.

The Guide does NOT impose new requirements or constitute Department policy. Nor is this Guide intended to instruct Federal employees in *how* to prepare life-cycle cost estimates. Rather, it provides information based on standard, commercial estimating practices and processes to meet Federal and DOE requirements and facilitate the development of local or site-specific cost estimating requirements.

The *DOE Cost Estimating Guide* will be assessed and updated periodically to reflect the latest DOE requirements and industry developments. The DOE Cost Engineering Group (DOE-CEG) is responsible for maintaining the information in the *DOE Cost Estimating Guide*.

More information on OECM can be found at

<http://oecm.energy.gov/>

More information on the DOE-CEG can be found at

http://oecm.energy.gov/cost_estimating/cost_index.html

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CHAPTER 1 - INTRODUCTION AND OVERVIEW

Section 1.1 - Summary of Requirements

Section 1.1 - Summary of Requirements

Section 1.3 - The Project Life Cycle

Section 1.4 - Input, Processes, and Output

Section 1.5 - Roles and Responsibilities

CHAPTER 1 explains, in general terms, *why* we do cost estimates and *when* in a project's life cycle cost estimates are required; provides an overview of the cost estimating "knowledge area," including inputs, processes (tools and techniques), and outputs; and describes *who* is responsible for *what*, in terms of cost estimates used within DOE.



KEY POINT

Throughout the DOE Cost Estimating Guide are boxes containing key points, which emphasize suggested practices that may not be well-known, but could be beneficial for future reference.

Some key terms used in this chapter include—

- Successful projects
- Federal requirements
- DOE requirements
- DOE Acquisition Management System
- Project life cycle
- Inputs, processes, and outputs

Section 1.1 - Summary of Requirements

A key objective of DOE is to manage *successful projects and programs*. The objective of this Guide is to improve the quality of cost estimates, in particular those supporting the execution of successful projects and programs. This Guide provides cost estimating principles and processes that meet Federal and DOE requirements, are consistent with industry standards and practices, and facilitate local requirements.

Generally, Federal requirements are promulgated by:

- Office of Management and Budget (OMB), which provides specifics for budgeting, discount rates, and management of projects (acquisitions) in their circulars.

-
- The Federal Acquisition Regulation (FAR), which provides Federal contract requirements for government estimates, cost and price analyses, and contract changes.
 - The Code of Federal Regulations (CFR), which provides requirements for alternative considerations and life-cycle cost analyses.
 - Various other Federal laws, such as the Government Performance and Results Act (GPRA), the Government Management Reform Act, the Federal Acquisition Reform Act, the Federal Acquisition Streamlining Act, the Information Technology Management Reform Act, the Chief Financial Officers Act (CFO Act), and others.

Acronyms are defined in Appendix A, and terms associated with cost estimating are defined in Appendix B. A more complete summary of the Federal requirements may be found in Appendix C.

These Federal laws and policies drive the way DOE conducts business. DOE's Directives Management System is the means by which departmental policies, requirements, and responsibilities are developed and communicated. Directives are used to inform, direct, and Guide employees in the performance of their jobs and enable employees to work effectively within the Department and with Agencies, contractors, and the public.

The most significant, relevant DOE Orders include:

- DOE O 130.1, *Budget Formulation*, dated 9-29-95.
- DOE O 413.3, *Program and Project Management for the Acquisition of Capital Assets*, dated 10-13-00.
- DOE O 430.1B, *Real Property Asset Management*, dated 9-24-03.
- DOE O 520.1, *Office of Chief Financial Officer*, dated 11-27-01.
- DOE O 534.1B, *Accounting*, dated 1-6-03.

A more complete summary of requirements from applicable DOE Orders may be found in Appendix D. Appendix E provides criteria for cost estimation reviews; Appendix F lists acquisition activities and deliverables; Appendix G addresses calculating and using cost escalation in estimates; Appendix H provides an example of life cycle cost analysis; Appendix I lists benchmarks; Appendix J provides two Association for the Advancement of Cost Engineering (AACE) recommended practices; and Appendix K provides a complete bibliography of publications applicable to cost estimating.

Each DOE program may have specific, detailed requirements for the DOE field offices to meet its needs. Examples include the National Environmental Policy Act (NEPA), safety and health, site security requirements, and local requirements, such as contracts, labor agreements, etc. Many of these requirements are implemented through the annual budget formulation and execution process. For instance, DOE's Budget Formulation Guidance includes very specific formats and directions for submitting project data sheets and the OMB Exhibit 300, Capital Asset Plan and Business Case.

Section 1.2 - Industry Standards and Recommended Practices

In the United States, responsibility for setting product and process standards rests almost exclusively with the private sector. Government agencies rely heavily on voluntary standards, which they often incorporate into regulatory and procurement requirements.

OMB Circular A-119, *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities*, defines voluntary consensus standards as—

“... standards developed or adopted by voluntary consensus-standards bodies, both domestic and international. These standards include provisions requiring that owners of relevant intellectual property have agreed to make that intellectual property available on a nondiscriminatory, royalty-free or reasonable-royalty basis to all interested parties.”

The National Technology Transfer and Advancement Act [Public Law (P.L.) 104-113] *mandates* that Federal departments and agencies use voluntary-consensus standards in place of Government standards wherever practical. For the purposes of this Guide, voluntary-consensus standards are defined in publications of the American Society for Testing Materials (ASTM) and the American National Standards Institute (ANSI).

- ASTM E2150-02, Standard Classification for Life-Cycle Environmental Work Elements, Environmental Cost Element Structure.
- ASTM E2083-00, Standard Classification for Building Construction Field Requirements and Office Overhead & Profit.
- ASTM E2168-01, Standard Classification for Allowance, Contingency and Reserve Sums in Building Construction Estimating.
- ASTM E2137-01, Standard Guide for Estimating Monetary Costs and Liabilities for Environmental Matters.
- ANSI Z94.4-1998, Cost Engineering and Project Management (developed by the Institute of Industrial Engineers) .

Although industry standards do not represent formal requirements, their use and reference are essential to establishing the best commercial business practices for use in government procedures. This Guide strives to incorporate best practices from commercial quality standards (ANSI/Electronic Industries Alliance, ASTM, etc.) and recommended practices (e.g., the Project Management Institute, the Association for the Advancement of Cost Engineering, the Society of Cost Estimating and Analysis, and the Construction Industry Institute).

For that reason, DOE has cooperative agreements with the Project Management Institute (PMI) and the AACE to promote the use of these industry standards. Several sections within this Guide will reference information from both PMI and AACE.

PMI's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide, 2000 Edition)* describes projects using process groups: initiating, planning, executing, controlling, and closing. These processes are linked by their results, so the completion of one process group usually indicates the beginning of another. For example, planning results in a project plan that is executed.

PMI explains the interactions (inputs, tools and techniques, and outputs) of the processes within each of its nine knowledge areas (integration, scope, time, cost quality, human resources, communications, risk, and procurement). This Guide acknowledges PMI's cost management knowledge area, and it is organized by inputs, processes, and outputs.

AACE has established recommended practices for various aspects of the cost engineering field. AACE Recommended Practices No. 17R97 and No. 18R97 define cost estimate classifications and characteristics. For this Guide, these recommended practices are being referenced and are included in Appendix J. DOE's joint agreement with AACE, dated August 2, 2002, has the following objectives.

- Advance the state-of-the-art of total cost management through increased communication and dialogue at the national and local section level, including involvement in committees and discussion groups.
- Apply established cost engineering and cost management principles, proven methodologies, and the latest technology in support of management processes.
- Develop new cost engineering and cost management methodologies and technology in pursuit of optimum resource utilization.
- Enhance the exchange of information, methodologies, and technologies to increase cost management and control.
- Encourage the utilization of cost management standards and practices and their continual improvement and advancement.
- Facilitate communication and understanding of the issues involved in and obstacles to the effective planning and control of costs, resources, and risks.
- Promote continued advancement and education in the skills and practice of total cost management to ensure the use of the most advanced and up-to-date methods and technology.
- Encourage accredited certification of cost management professionals to increase the public's confidence in the cost management of government programs.

More information on the DOE Directives system may be found at <http://www.directives.doe.gov/>.

More information on DOE Budget Formulation may be found at <http://www.mbe.doe.gov/budget/>.

More information on OMB A-11 and Exhibit 300 may be found at <http://www.whitehouse.gov/omb/circulars/index-budget.html>.

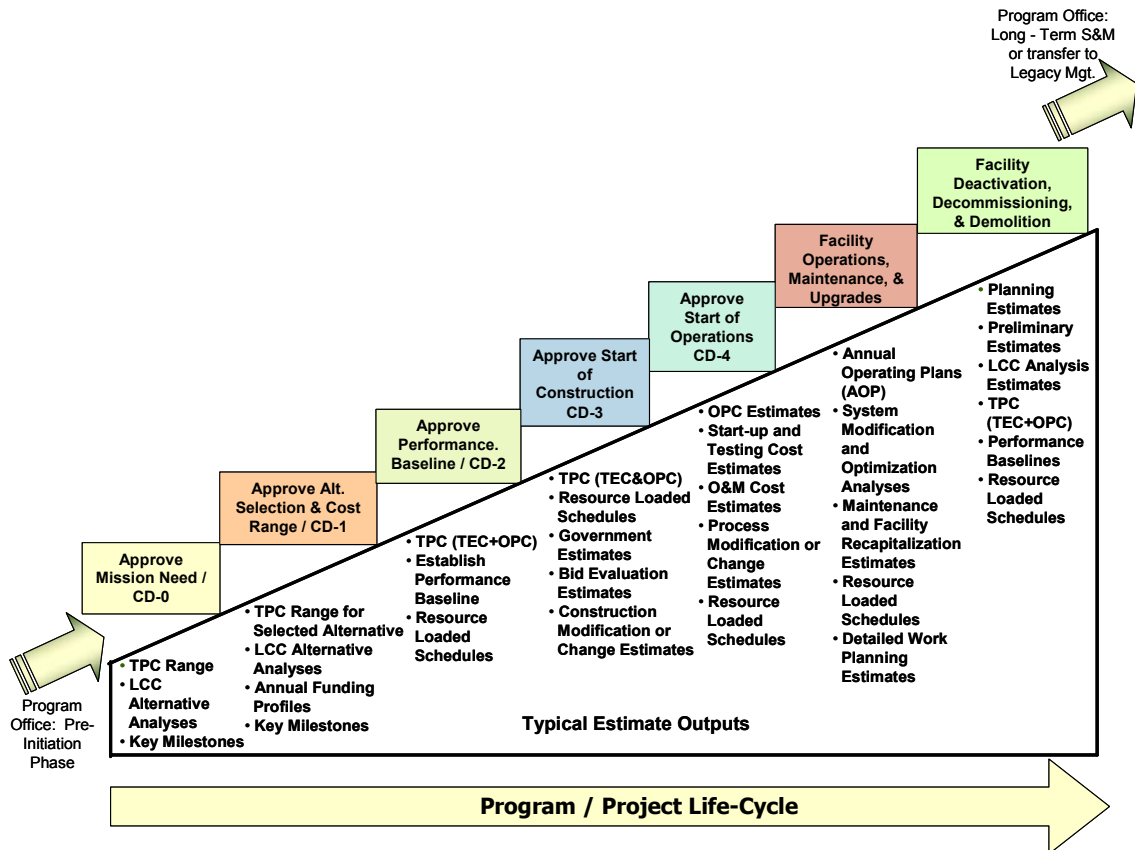
More information on PMI may be found at <http://www.pmi.org/info/default.asp>.

More information on AACE may be found at <http://www.aacei.org/>.

Section 1.3 - The Project Life Cycle

During the life of a project, cost estimates and related documents are required to facilitate the acquisition and document project planning and development and changes required throughout the project. Common cost estimating documents are shown in Figure 1–2.

Figure 1–1. Project/Program Life-Cycle Stages



Derived from information contained in the *DOE Project Management Manual* and other DOE requirements, cost estimates are required for—

- ***Critical Decision (CD)-0, Approve Mission Need***

Normally, cost estimates prepared to support CD-0 will be Class 5, Order of Magnitude and may utilize several techniques in development. There will likely be very little detail to support these cost estimates, so scope assumptions should be documented as necessary. A range should be established based on project alternatives. Normally, depending on techniques used, there will be little, if any, distinction between components or categories within the cost estimate (e.g., direct costs, indirect costs, contingency, or escalation; labor, materials, equipment, etc.; types of work).

- ***CD-1, Approve Alternative Selection and Cost Range***

Cost estimates prepared to support CD-1 will range from Class 5, Order of

Magnitude to Class 3, Preliminary cost estimates, using several cost estimating techniques. For alternatives explored, varying levels of available information should be expected. Ranges should be a little more refined than those at CD-0, but still established based on the range of project alternatives.

- ***CD-2, Approve Performance Baseline***

Cost estimates supporting CD-2 will likely be Class 3, Preliminary to Class 1, Definitive and utilize more of the definitive cost estimating techniques. For CD-2, since information available will be well developed, there will no longer be a range. A single cost estimate will represent the entire project, utilizing the preferred alternatives established earlier in the project.

With approval of CD-2, a performance baseline is established for the project.

- ***Various Contract Actions***

During the normal course of a project or program, DOE prime and subcontractor actions are inevitable. Contract actions commonly entail a government estimate, a proposed estimate, and some agreed-to estimates. Depending on contract types and other factors, varying levels of information will be available facilitating the use of varying cost estimate classifications and techniques in cost estimate development.

- ***Various Budget Actions***

During the normal course of a project or program, budgets are sometimes adjusted to accommodate appropriations and allocation being more or less than expected. Some adjustments require estimated “What happens if . . . ?” scenarios to depict alternative courses. As budgets are adjusted, baselines and estimates for current-period work (work packages) should also be adjusted accordingly.

- ***Various Project Changes***

During the normal course of a project or program, cost estimates are required to support project management decisions. In many cases, alternatives are considered that do not affect the entire project but do affect the day-to-day details of managing a project, for instance, detail changes that do not exceed a cost or schedule threshold for management approval.

- ***Life-Cycle Cost Analysis***

Life-cycle cost analysis (or cost-benefit analysis, economic analysis, etc.) is required for many purposes. For the critical decision process, analysis is required at each decision point to ensure that correct paths are taken. As a part of alternative selection, life-cycle cost analysis will formally point to the alternative with the lowest life-cycle cost. Any time a project encounters a change, or finds some alternative to be considered, life-cycle cost analysis should be considered.

Cost estimates for program activities are an integral part of the Department’s planning, programming, budgeting, and evaluation process, which provides a systematic framework for prioritizing program needs, allocating resources, measuring performance, and delivering results. Accurate cost estimates are critical to the Department’s ability to successfully plan and execute its missions.

All Departmental elements prepare estimates on an annual basis to account for planned expenditures related to required program operating expenses, plant acquisition and construction activities, capital equipment not related to construction, and capital asset acquisition activities. These estimates not only support the planning and budgeting processes, they also provide the yardstick against which the cost performance of a program or project is measured.

The standard cost estimating practices and techniques presented throughout this Guide should also be used when developing estimates required for working capital fund activities, general plant projects, institutional general plant projects, research and development (R&D), project engineering and design (PED), construction management, project management, information technology, other project costs, annual facility operations, maintenance and repair, recapitalization, programmatic operating activities directed related to facility operations, deactivation, demolition, and legacy management. Cost estimates developed using the practices and techniques presented herein may also be components of ten-year site plans, disposition plans for closure sites, integrated facilities and infrastructure crosscut budgets, annual operating plans, current-year work plans, detailed work plans, or other applicable business-related processes used by the Department.

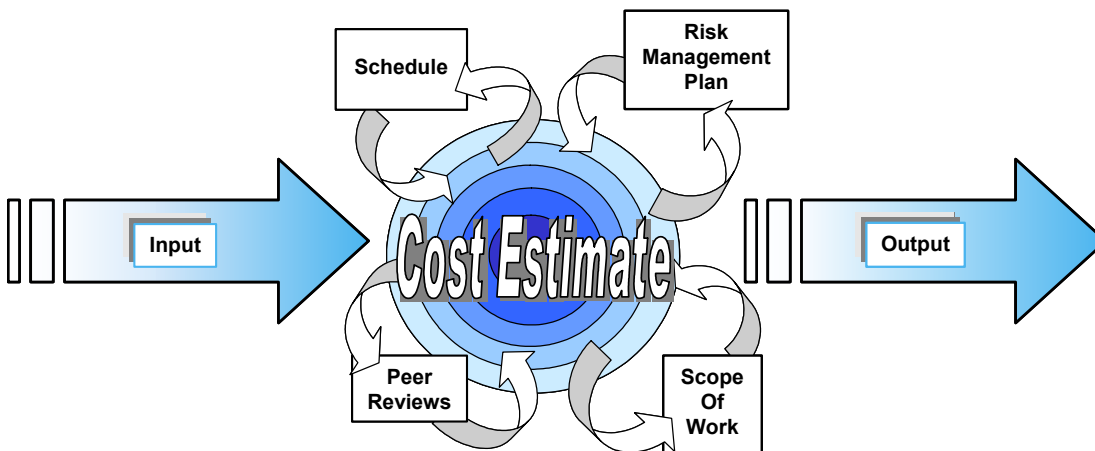
DOE's Project Management Manual can be found at

<http://www.directives.doe.gov/pdfs/doe/doetext/neword/413/m4133-1.html>

Section 1.4 - Input, Processes, and Output

Traditionally, cost estimates are developed by gathering input, going through the process of developing the cost estimate and its documentation, and generating necessary output. Figure 1–2 depicts the cost estimate development process, which should be similar for cost estimates at various points within the project life cycle. Cost estimates, schedules, risk management plans, and peer reviews are very closely related. None should stand alone.

Figure 1–2. Cost Estimating process



These process interactions—inputs, processes (tools and techniques), and outputs—are used by PMI and others to depict the transfer of information between steps in a knowledge area such as cost estimating. This graphic depicts these interactions and is the

basis for the organization of this Guide. Inputs are discussed in Chapter 2; the processes, or cost estimate development and documentation, are discussed in Chapter 3; and the outputs, or uses of cost estimates, are discussed in Chapter 4.

Section 1.5 - Roles and Responsibilities

Guides do not contain requirements. As such, this Guide is intended to be used by DOE and contractor cost estimators, project directors, project managers, and other personnel involved in the acquisition and operations of DOE facilities. Each prime DOE contractor and DOE field or program office should incorporate this Guide into their operating procedures to ensure consistency and standardization across the DOE.

Although this Guide does not provide explicit how-to information, it is expected that DOE and contractor personnel at respective DOE sites and field offices will use it to obtain a working knowledge of cost estimating and analysis, including how cost estimates are used throughout the planning and execution of DOE missions.

Table 1-1 provides a listing of roles and responsibilities for those involved in cost estimating for the department.

Table 1-1. Roles and Responsibilities

Roles	Responsibilities
DOE-OECM	<ul style="list-style-type: none"> • Maintains DOE policy and requirements for acquisitions, or projects. • Sponsors the DOE-Cost Engineering Group (DOE-CEG).
DOE-CEG, by charter	<ul style="list-style-type: none"> • Maintains the DOE Cost Estimating Guide and other activities as directed by OECM. • Includes Federal and contractor project management and cost estimating representatives. • Promotes cost estimating consistency and standardization across the DOE complex. • Promotes the use of industry standards and commercial/corporate experience to establish effective benchmarks.
DOE Headquarter Program Offices	<ul style="list-style-type: none"> • Maintain the missions of the DOE. • Provide, as required, program-specific guidance to implement DOE's policies and requirements. • Responsible for internal project reviews and validations. • Participate in the DOE-CEG.
DOE site offices, including DOE Project Directors and Integrated Project Teams (IPTs)	<ul style="list-style-type: none"> • Implement missions of the DOE. • Submit budgets, administer contracts, and manage projects in implementing DOE missions. • Provide, as required, more specific guidance to implement DOE's policies and requirements. • Responsible for cost estimate reviews and validations. • Typically own cost estimates. • Participate in the DOE-CEG.
Contractors	<ul style="list-style-type: none"> • Assist DOE in implementing its missions. • Comply with DOE requirements and meet cost estimating expectations. More specifically, develop various cost estimates for budgeting, contracting, alternative analysis, etc., to be used by DOE. • Typically prepare cost estimates for DOE site offices. • Participate in the DOE-CEG.

Integrated Project Teams (IPTs)

An IPT is a cross-functional group of individuals organized for the specific purpose of delivering a project to an external or internal customer. Team members are representative of all competencies that influence the project's overall performance. IPTs are expected to include cost estimating professionals.

The IPT should be committed to a common purpose and approach for which members are held mutually accountable. Team members are trained by their home departments/organizations to execute standard processes and exercise technical and/or business judgment within established policies in support of the assigned project.

Members of an IPT represent technical, manufacturing, business, contracting, and support functions and organizations that are critical to developing, procuring, and supporting the product. Depending on the project needs, typical IPT membership could include legal, quality, safety, environmental, and technical personnel.

If possible, IPT members are assigned for the length of time required to complete their IPT assignments. Therefore, depending on the relative impact of a team competency, team membership may be either full-time or part-time.

An IPT is the means by which the acquisition process is implemented. The IPT is the overall project support team having responsibility for pre-project and project development, design/engineering, and construction/remediation activities, as appropriate. As a project progresses from initiation to transition/closeout completion, IPT membership may, at the discretion of the project manager, change in both members and capabilities to remain responsive to project needs and requirements.

Cost estimators and cost engineers participating in an IPT should be cognizant of the relationships with other functional areas, such as budgeting, finance, contracting, etc.

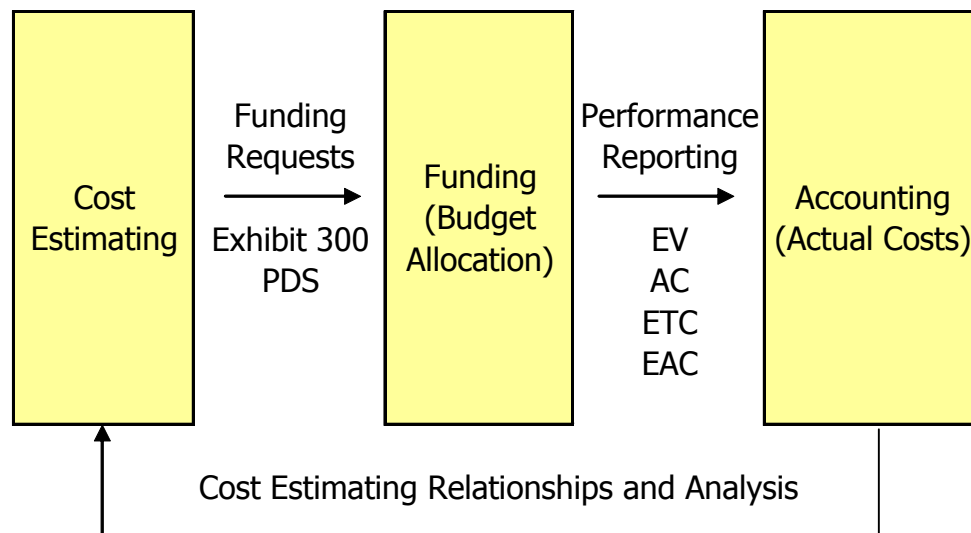
Section 1.6 – Terminology Relationships

Cost estimating terms are often confused with budget and accounting terms, so that budget and accounting terms are used during cost estimating and cost estimating terms are used during budgeting and accounting. This section looks at how we can put cost estimating terms in proper perspective.

Cost terms used over the course of a project differ according to the project's financial phases (i.e., cost estimate, budget, accounting). The primary terms used when developing a cost estimate—direct costs, indirect costs, escalation, and contingency—are used when budgets are formed but are not used when final accounting is done. Some budgeting terms, such as performance baseline, budget authority, and budget obligation are seldom used when costs are being either estimated or accounted for.

There is a relationship among the terms of the three phases, however. Cost information established during the cost estimate phase is used in creating budgets, budget information is used when accounting the actual costs of the project, and the accounted costs of one project become the historical data used in developing cost estimates for subsequent projects.

Figure 1-3, below, illustrates how this terminology relationship works.

Figure 1–3. Cost Estimate Terminology Relationships

CHAPTER 2 - COST ESTIMATING INPUTS

SECTION 2.1 - PROJECT INTERFACES

SECTION 2.2 - CONTRACT TYPES

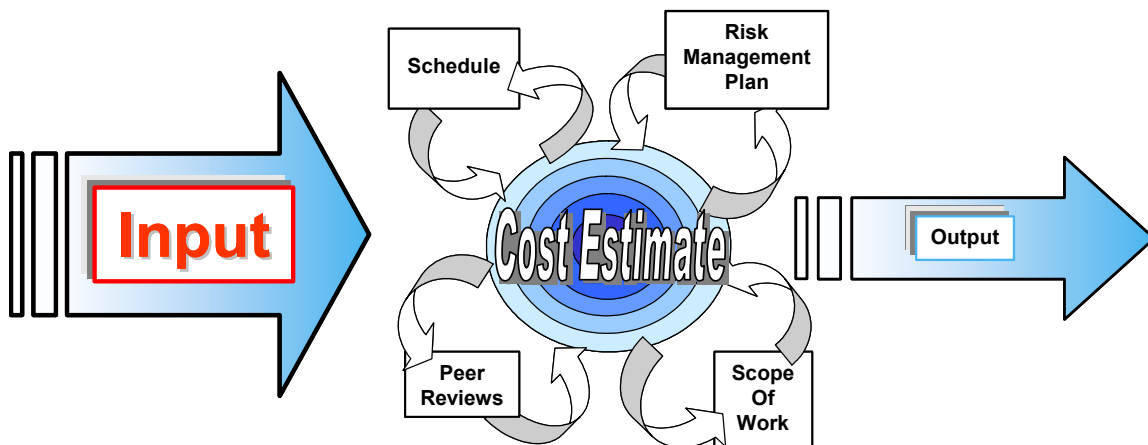
SECTION 2.3 - COST ESTIMATE PURPOSES

SECTION 2.4 - COST ESTIMATE CLASSIFICATIONS

SECTION 2.5 - COST ESTIMATE TECHNIQUES

In CHAPTER 2, COST ESTIMATING INPUTS, Figure 2–1, Cost Estimating Process, provides an understanding of what generally happens (or should happen) early in the development of a cost estimate. Chapter 2 goes on to explain some of the project interfaces (both one-time and iterative), contract types utilized, cost estimate purposes, classifications, and techniques.

Figure 2–1. Cost Estimating Process



Some terms used in this chapter include:

- Interfaces
- Performance-based contracting
- Government estimates
- Contract types
- Cost estimate purposes
- Cost estimate classifications
- Cost estimate ranges
- Cost estimate techniques

Section 2.1 - Project Interfaces

Cost estimate development is initiated by *inputs* to the process. These inputs are either one-time or iterative processes. One-time inputs may include the project charter, project execution plan, acquisition strategy, and the acquisition plan. One-time inputs to the cost estimating process will not necessarily evolve with the cost estimating process.

Other inputs are iterative and do evolve through the cost estimating process. They include risk identification and mitigation strategies, schedule, and technical/scope development. Peer reviews, too, are iterative, since input to and by cost estimating peers may affect the quality of the cost estimate. Peer reviews should be required before any external reviews are conducted. Peer reviews are discussed in more depth in Chapter 3.

Section 2.2 - Contract Types

Government estimates are required before most acquisitions and may become either the basis for contract negotiations or important in the case of settling claims. All DOE cost estimates, including government estimates in contracting, should follow the cost estimating process.

Before determining the content of an estimate, it is pertinent to understand the contract types that will be used to execute the work. Establishing appropriate *contract type* will help determine activities and accounts to be established and reported. Contract types typically reflect a level of technical definition, size, and complexity of activities, and are based on an established scope of work. The contract type that will be used to execute the work may be affected by a program's contracting strategy, but it may also be specific to a particular project or the activities within a project.

Most DOE projects fall into the category of cost-reimbursable contracts. Generally, fee determination in a cost-reimbursable (cost-plus) contract distinguishes whether it is performance based. In order to fulfill mission needs, DOE programs and projects are responsible for the planning and procurement of contracts. *Performance-based contracting* is a preferred contracting method that requires discrete, quantifiable, and measurable objectives tied to an incentive fee. A project baseline (established at CD-2) and near-term contracts, or work packages, should also have characteristics that are discrete, quantifiable, and measurable.

Common to DOE's large contracts are the site/facility management (management and operating) contracts and the management and integration contracts. Most DOE work is contracted to universities and corporations, through site/facility management contracts, and small businesses. However, DOE also has numerous other contract types in place, all dependent on the project or contract level of definition and technical risks.

All contract types have some aspect of performance related to them. Performance objectives are easiest to quantify and measure in projects with definitive scopes of work. Design-build contracts may be managed as fixed-price or cost-reimbursable contracts (or subcontracts) and should be:

- Commensurate with project size, complexity, risks, and maturity
- Appropriate for the situation

Table 2-1. Contract Types

Type of Contract	Characteristics
Fixed-Price or Lump Sum	Includes material, labor, equipment, subcontracts, indirect costs, overhead, profit, contingency, and escalation. These are typically well defined and include low technical risks.
Cost-Plus Fixed Fee	Includes reimbursement for material, labor, equipment, subcontracts, indirect costs, overhead, and escalation. Fee is <i>not</i> determined by performance; it is fixed.
Cost-Plus Award Fee	Includes reimbursement for material, labor, equipment, subcontracts, indirect costs, overhead, and escalation. Fee is determined by performance. Cost-plus award is the most <i>subjective</i> of the cost-plus contract types.
Cost-Plus Incentive Fee	Includes reimbursement for material, labor, equipment, subcontracts, indirect costs, overhead, and escalation. Fee is determined by performance.
Labor Hour Contracts	Material, labor, equipment, subcontracts, indirect costs, overhead, profit, and escalation are rolled into an hourly labor rate.
Unit Cost Contracts	Material, labor, equipment, subcontracts, indirect costs, overhead, profit, and escalation are rolled into costs per unit.
Task-Order Contracts	Similar to labor hour contracts, except oriented to specific tasks.

Consistent with the project's acquisition strategy, profit, or fee, may be included in a contractor's indirect rate (see Section 3.2.2, Indirect Costs), depending on contract type, financial system, or other circumstance. *Fee* is normally associated with cost-plus contracts and is determined based on pre-established performance objectives or an assessment of other criteria (e.g., cost-plus-incentive-fee). *Profit* is normally associated with a fixed-price contract and is unknown until all costs have been incurred. Profit is sometimes referred to as the "wages of risk." Both fee and profit should be commensurate with the risks involved.

Section 2.3 - Cost Estimate Purposes

Cost estimates and life-cycle cost analyses are produced for many reasons. These purposes include support to:

- The critical decision process within programs/projects (DOE O 430.1 and DOE O 413.3)
- The annual budget process (DOE O 130.1)
- Contract actions
- Other project/program management purposes (various Federal regulations, DOE Orders, and industry practices). This includes the development of economic analysis, cost-benefit analysis, life-cycle cost analysis, value engineering studies,

earned value analysis, and support of change control. Some of these topics are discussed more specifically in later chapters.

Summaries of the Federal and DOE requirements can be found in Appendix C and D.

Section 2.4 - Cost Estimate Classifications

The five DOE cost estimate classifications are based on AACE's Recommended Practice for Classifying Cost Estimates (AACE International Recommended Practice No. 17R-97; see Appendix J). They are listed in **Table 2-2**, along with their primary characteristics.

Table 2-2. Cost Estimate Classifications

Cost Estimate Classification	Primary Characteristics	
	Level of Definition (% of Complete Definition)	Cost Estimating Description (Techniques)
Class 5, Order of Magnitude	0% to 2%	Stochastic, most parametric, judgment (parametric, specific analogy, expert opinion, trend analysis)
Class 4, Intermediate	1% to 15%	Various, more parametric (parametric, specific analogy, expert opinion, trend analysis)
Class 3, Preliminary	10% to 40%	Various, including combinations (detailed, unit-cost, or activity-based; parametric; specific analogy; expert opinion; trend analysis)
Class 2, Intermediate	30% to 70%	Various, more definitive (detailed, unit-cost, or activity-based; expert opinion; learning curve)
Class 1, Definitive	50% to 100%	Deterministic, most definitive (detailed, unit-cost, or activity-based; expert opinion; learning curve)

AACE's Recommended Practice No. 18R-97 (Appendix J) includes a more complete description of AACE's classifications. DOE's cost estimate classifications follow these recommended practices, generally, although historically the more common cost estimate classifications are order of magnitude, preliminary, and definitive, which approximately equate to Classes 5, 3, and 1, respectively.

Cost estimates have common characteristics, regardless of whether the technical scope is traditional (capital funded, construction type) or nontraditional (expense funded, operations type). The common characteristics are levels of definition, requirements, and techniques. Typically, as a project evolves, it becomes more definitive. Cost estimates depicting evolving projects also become more definitive over time.

The cost estimate classifications may be used with any type of traditional or nontraditional project and include consideration of

- where a project stands in its life cycle
- level of definition (amount of information available)
- techniques to be used in estimation (e.g., parametric vs. definitive)
- time constraints and other estimating variables

Determination of cost estimate classifications will help ensure that cost estimate *quality* is appropriately considered. Classifications may also help determine

- appropriate application of contingency,
- escalation,
- use of direct/indirect costs (as determined by cost estimate techniques), etc.

Class 5, Order of Magnitude Cost Estimates

Class 5, Order of Magnitude cost estimates, also known as rough order of magnitude (ROM) or top-down cost estimates, are typically performed in the early stages of a project's life. These cost estimates are based on the least amount of available information and may portray a low level of confidence or accuracy.

Class 4, Intermediate

Class 4, Intermediate cost estimates are seldom used, but could typically include a combination of Class 5 and Class 3 cost estimates.

Class 3, Preliminary

Class 3, Preliminary, or budgetary, cost estimates are those that contain diverse levels of available and supporting information, use various techniques, and portray a moderate level of confidence.

Class 2, Intermediate

Class 2, Intermediate cost estimates are seldom used, but could typically include a combination of Class 3 and Class 1 cost estimates.



KEY POINT

As a general rule, even for projects in early stages of development, cost estimate classification should reflect more definitive scope development for the near-term portions of work. This may be referred to as “rolling-wave” planning, where detailed planning of future work is done in increments, or waves as the project progresses through phases.

For instance, cost estimates early in a project's life may include—

- Class 1—Definitive cost estimates and scope for more defined near-term work (e.g., the design and scope development phases)
- Class 5—Order of Magnitude cost estimates for the less defined long-term work (e.g., execution, construction, and project close-out phases)

Class 1, Definitive

Class 1, Definitive cost estimates, also known as detailed, detailed unit-cost, or activity-based cost estimates, are those with the most abundantly available support information, typically using a definitive technique for development and representing a greater level of confidence.

As a general rule, particularly for projects that are in the early stages of development, a combination of estimate classifications must be used to develop the entire life-cycle cost estimate. In these situations, estimators should use a combination of detailed unit cost estimating (Class 1) techniques for work that will be executed in the near future, preliminary estimating (Class 3) techniques for work that is currently in the planning stages but less defined, and order of magnitude estimating (Class 5) techniques for future work that has not been well defined. As a project progresses through the Acquisition Management System (initiation, definition, execution, and transition/closeout phases) and the project development and planning matures, the life-cycle cost estimate becomes more definitive in nature and substance.

Cost Estimate Ranges

DOE O 413.3 requires the use of ranges to express project cost estimates. These ranges should depict TPCs in the early stage, normally before the commitment to a performance baseline. Ranges should be shown in escalated dollars and may be determined or based upon various:

- Project alternatives
- Projected risks
- Confidence levels (Remember: “*Planning for Success!*”)

The Department’s Acquisition Management System includes decision points that identify exit points from one phase of project development to entry into the succeeding project phase.

During a project’s initiation phase, the program defines the capability it needs to acquire. The program also provides a cost range, a timeline that includes key milestones, and a profile of anticipated funding requirements based on the upper bound of the cost estimate. It is important to note that, during the project initiation phase, the mission need is defined in terms of needed capability rather than the specific acquisition of a capital asset. During this phase of a project, many alternatives will be evaluated to meet the identified need.

The cost range developed at this point in the project planning process will represent all viable alternatives considered to achieve the required performance capability. These estimates also should include costs for exploring alternative concepts and the development of solutions and alternatives during the project definition phase.

Life-cycle cost estimates that are developed early in a project’s life may not be derived from detailed engineering, but they must be sufficiently developed to support budget requests for the remainder of the project definition phase. They should also include all anticipated resources, using appropriate estimating techniques that are necessary to acquire or meet the identified capability.

During the project definition phase, at the conclusion of the concept exploration process, the alternative selected as the best solution to a mission need is presented for approval. The solution presented as a subset of a conceptual design report must include the TPC range, a schedule range with key milestones and events, and annual funding profiles. The TPC range presented must be a risk-adjusted cost estimate that defines all required resources necessary to successfully execute the planned work.

The estimate range (lower and upper bounds) is established by considering a risk analysis conducted by the project team. A risk analysis is certainly analytical in nature and, although simulation tools aid the analyst in assessing impact and consequences, no simulation tool can substitute for a thorough logical deterministic process. The risks are identified by the likelihood of occurrence and the probable impact if the risk occurs.

The lower bound of the cost range will likely represent a scenario where the project team has determined a low likelihood of occurrence of identified risks. The risks are accepted; therefore it is not necessary to include resources to mitigate them.

The upper bound of the cost range will likely represent a scenario where the project team has determined a high likelihood of occurrence of identified risks. The risks will be planned for and managed and appropriate resources to mitigate them will be included.

Section 2.5 - Cost Estimate Techniques

Several cost estimating techniques are available to facilitate the cost estimating process. Depending on project scope, estimate purpose, project maturity, and availability of cost estimating resources, the estimator may use one, or a combination, of these techniques. The following sections include techniques that may be employed in developing cost estimates.

Section 2.5.1 - Detailed, Unit-Cost, or Activity-Based

Detailed, unit-cost, or activity-based cost estimates are the most definitive of the estimate techniques and use information down to the lowest level of detail available. They are also the most commonly understood and utilized estimating techniques.

The accuracy of detailed, unit-cost, or activity-based techniques depends on the accuracy of available information. A work statement and set of drawings or specifications may be used to identify activities that make up the project.

Each activity is further broken down so that labor hours, material costs, equipment costs, and subcontract costs (or other unit-cost-type items) are itemized and quantified. Subtotaled, these form direct costs. Indirect costs, overhead costs, contingency, and escalation are then added as necessary. The estimate may be revised as known details are refined. The detailed, unit-cost, or activity-based estimating techniques are most used for Class 1 and Class 2 estimates.

Activity-based cost estimates, detailed cost estimates, check estimates, bid estimates, construction estimates, and other terms imply that activities, tasks, work packages, or planning packages [the lowest level of the work breakdown structure (WBS)] are well-defined, quantifiable, and are to be tracked, so that performance can be measured accurately. Quantities should be objective, discreet, and measurable.

Section 2.5.2 - Parametric, or Top-Down

Parametric estimating produces higher-level estimates when little information, other than basic parameters, is known about a project. For example, a building's cost can be estimated given only its size, purpose, and general site information.

A parametric estimate requires the use of cost estimating relationships (CERs), also known as cost models, composites, or assemblies/subassemblies, which are developed from historical data by similar systems or subsystems. CERs are correlations between cost drivers and system parameters, such as design or performance requirements (a quantity of something). A CER can be used individually or grouped into more complex models.

Parametric estimates are commonly used in conceptual and check estimates and are normally developed using computerized software. A limitation to the use of CERs is that to be most effective, one must understand completely how the CER was developed and where and how indirect costs, overhead costs, contingency, and escalation are applicable. The parametric estimating technique is most appropriate for Classes 5, 4, and 3 cost estimates. The parametric technique is best used when the design basis has evolved very little detail but the overall parameters have been established.

Section 2.5.3 - Level of Effort

A form of parametric estimating is based on level of effort (LOE). Historically, LOE is used to project future operations costs based on past cost data that tells us, "*we spent ~\$10M on operations last year, so we need ~\$10M next year.*" Normally, but not in all cases, these include few parameters or performance objectives provided from which to measure or estimate. They are normally based on hours, full-time equivalents (FTEs), or "1 lots." Since they are perceived to have little objective basis, LOE estimates are often subject to scrutiny. The keys to LOE estimates are that they should

- generally be based on known scope (although particular quantities may be assumed) and
- have a basis, even if it is simply the opinion of an expert or the project team (see the other estimating techniques).

Parametric and LOE estimates are used where

- there is not much known about a particular thing or activity or
- the productivity and costs of an activity are carried for several time periods at a similar rate (e.g., the costs of operations, such as X number of operators for Y amount of time).

In many cases, LOE estimates are performed simply due to lack of time to prepare a thorough cost estimate. LOE estimates are most appropriate for parts of a project where there is little empirical data to support factors such as material unit costs, labor productivity, or equipment usage in installation. Determining LOE may also rely on input from the project team to establish approximate scope, cost, and schedule to be attributed to the particular WBS element or account code.

Variations on LOE are many and should be considered carefully before deciding to employ that technique. For instance, if you have an LOE for motor installation, it may raise questions about why it does not include the circumstances surrounding its installation (contamination and security productivity adjustments). Also questionable in LOE estimates are indirect costs, overhead costs, profit/fee, and other assumptions.

Section 2.5.4 - Specific Analogy

Specific analogies use the known cost or schedule of an item as an estimate for a similar item in a new system. Adjustments are made to known costs to account for differences in relative complexities of performance, design, and operational characteristics.

A variation of this technique is the “review and update technique,” where an estimate is constructed by examining previous estimates of the same or similar projects for logic, scope completion, assumptions, and other estimating techniques, and then updated to reflect any pertinent differences. The specific analogy technique is most appropriate in the early stages of a project, for Classes 5 and 3 cost estimates.

Section 2.5.5 - Expert Opinion

Expert opinion is an estimating technique whereby specialists are consulted until a consensus can be established regarding the cost of a program, project, sub-project, task, or activity. The expert opinion technique is most appropriate in the early stages of a project, for Classes 5, 4, and 3, cost estimates. These cost estimates include a list of the experts consulted, their relevant experience, and the basis for their opinions.

A formalized procedure, the Oracle Method, has been used to forecast cost based on expert opinion. Six or more experts are given a specific, usually quantifiable, question. Each expert sees the estimates produced by the others and modifies his or her previous estimate until a consensus is reached. If after four rounds there is no consensus, the original question may be broken into smaller parts for further rounds of discussion or a moderator may attempt to produce a final estimate.

This technique may be used for either portions of or entire estimates and activities for which there is no other sound basis. A limitation arises when a cost estimator’s or project manager’s status as an expert is questioned.

Section 2.5.6 - Trend Analysis

Trend analysis is an estimating technique for current, in-progress work. A trend is established using an efficiency index derived by comparing originally planned costs (or schedules) against actual costs (or schedules) for work performed to date. The derived cost/schedule indices are used to adjust estimate of work not yet completed.

The trend analysis technique can be used at almost any stage of project development and can even be used to update cost estimates developed using other techniques.

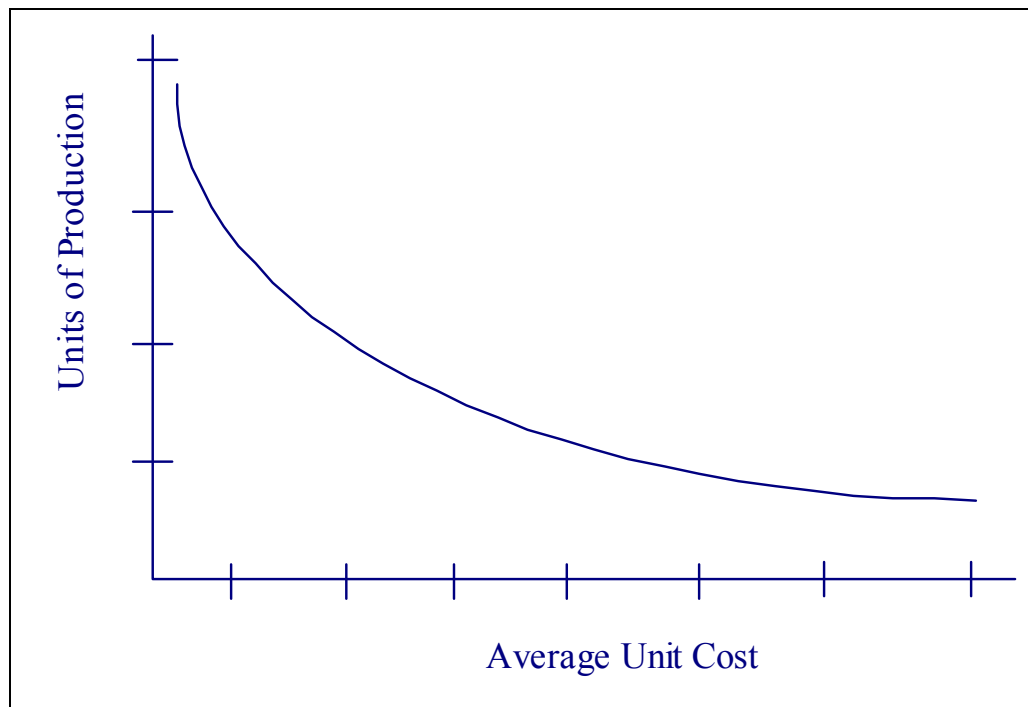
Section 2.5.7 - The Learning Curve

The learning curve is a way to understand the efficiency of producing or delivering large quantities. As studies have found, people engaged in repetitive tasks will improve their performance over time. That is, for large quantities of time and units, labor costs will

decrease, per unit.

The aircraft industry first recognized and named the learning curve and successfully used it in estimating. It can be used most effectively when new procedures are being fielded and where labor costs are a significant percentage of total unit cost. But it should always be understood that the learning curve applies only to direct labor input. Materials and overhead will not necessarily be affected by the learning curve. Figure 2–2 illustrates the theoretical use of the learning curve.

Figure 2–2. The Learning Curve



Typical learning curves start with high labor hours that decrease rapidly on initial units and then level out. This exponential relationship between labor productivity and cumulative production is expressed in terms of labor reduction resulting from production increases. For example, a 90-percent learning curve function requires only 90 percent of the labor hours per unit each time production doubles. When a total of 200 units are produced, labor costs for the second 100 units will be only nine tenths the cost of the first 100.

Increased productivity allows for lower labor costs later in a project, and can result in lowered overall project cost. Subsequent similar projects should have fewer labor hours for each unit of production also, which has potential to allow for more contractor profit and lower government contract costs.

No standard reduction rate applies to all programs, and learning curve benefits will vary. When labor hour reductions of the first units are known, an accurate percentage reduction can be calculated and extended to subsequent units. If no data exists, it may be risky to assume that learning curve savings will be experienced.

The learning curve estimating technique is applicable for consideration in all traditional and nontraditional projects. The learning curve has been proven to be effective in the most repetitive projects and activities. The learning curve also is used to update labor hours calculated in earlier estimates.

Section 2.5.8 - Methods of Estimating Other Life-Cycle Costs

Different methods may be used to estimate other project/program support costs, including design, engineering, inspections, ES&H, etc. Some common methods are count drawings and specifications, FTE, and percentage.

Count Drawings and Specifications Method

The estimator calculates the number of drawings and specifications representing a specific project. The more complex a project is, the more drawings and specifications it will require meaning that associated design costs will be higher.

Full-Time Equivalent Method

The number of individuals that are anticipated to perform the design functions of a project is the basis. The man-hour quantity is calculated and multiplied by the cost per labor hour and the duration of the project to arrive at the cost.

Percentage Method

The estimator calculates a certain percentage of the direct costs and assigns this amount to the design. Former Federal statutes limited the architect/engineer (A/E) portions of design costs to 6 percent of construction costs. Although this statute may be outdated, it is still good practice to limit this spending, to the extent practical. total design percentages are usually 15-25 percent.

CHAPTER 3 - COST ESTIMATING PROCESSES

SECTION 3.1 - COST ESTIMATE DEVELOPMENT

SECTION 3.2 - COST ESTIMATE CONTENTS

SECTION 3.3 - REVIEWS

Each section of CHAPTER 3, COST ESTIMATING PROCESSES is important because it describes how information is obtained (as described in Chapter 2, Cost Estimating Inputs) and then becomes a product (as described later, in Chapter 4, Cost Estimating Outputs). Chapter 3 discusses these processes and provides useful information on information gathering, cost estimate production, documentation, cost estimate contents, and reviews.

Some terms used in this chapter include:

- Cost estimate
- Cost estimating
- Work breakdown structure (WBS)
- Code of Accounts (COA)
- Basis of estimate
- Direct cost
- Indirect cost
- Management reserve
- Contingency
- Escalation rates
- Discount rates
- Activity
- Schedule
- Reconciliation
- Allowances
- Deterministic vs. Probabilistic
- Reviews
- Objective vs. Subjective
- Ranges

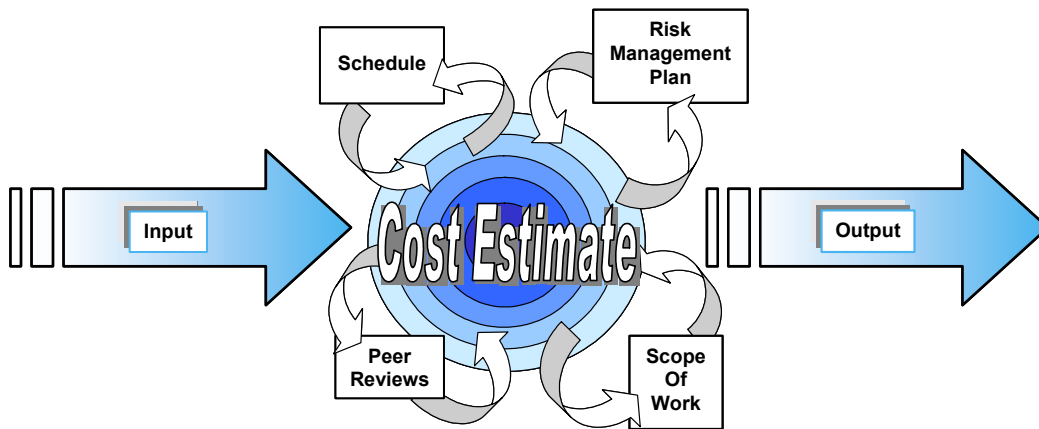
Section 3.1 - Cost Estimate Development

Cost estimate development, as described in this section and as shown below Figure 3–1, has three primary phases: *information gathering*, which consists of one-time and iterative inputs; cost estimate *production*, and *documentation*, which includes a cost estimate's basis of estimate. Cost estimate contents are contained in Section 3.2 and reviews are discussed in Section 3.3.

A cost estimate

- is a compilation of all the costs of the elements of a project or effort included within an agreed-upon scope
- is the yardstick against which cost performance may be measured, and as a result,
- is a predictive process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project

As a predictive process, estimating must address risks and uncertainties. The outputs of estimating are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project planning, or for project cost and schedule control processes.

Figure 3–1. Cost Estimating Process

Section 3.1.1 - Information Gathering

When given the task of developing an estimate, an estimator must first gather general project information, including—

- project background,
- where the project stands in its life cycle,
- general description of the technical scope,
- pertinent contract or sub-contract information,
- estimate purpose, classification, and techniques anticipated, and
- approximate time frame for the estimate to be performed.

Some specific inputs to the cost estimating process include—

- | | |
|--|---|
| • Mission Need Statement | • Preliminary Design |
| • Critical Decisions | • Definitive Design |
| • Acquisition Strategy | • Risk Management Plan |
| • Project Execution Plan | • Historical Info and Other Sources Of Information, Including Previous Cost Estimates |
| • Work Breakdown Structure (WBS) | • Results of Alternative and Requirements Analyses |
| • Code of Accounts (COA; also known as account code) | • Applicable Resources and Labor Rates |
| • Key Milestone Activities and Proposed Dates | • Applicable Indirect Rates |
| • Functional Design Criteria | • Assumptions |
| • Functional Performance Requirements | • Exclusions |
| • Conceptual Design Report | • Construction and Operations Input |

From this information, whether provided by others or developed by the estimator as an assumption, appropriate estimating techniques may be determined.

Section 3.1.2 - Cost Estimate Development

This second step in the estimating process is the development of the cost estimate and its corresponding schedule and basis of estimate. It is important that scope development, documentation, and control be coordinated with the cost estimate production as key iterative processes. Cost estimate production includes several steps that should be based on requirements, purpose, classification and technique.

- Become familiar with a scope of work.
- Identify the project, subprojects, milestones, activities, and tasks.
- Perform quantity-takeoffs and field walk-downs.
- Obtain budgetary or contract-supplied vendor information or market research, or establish other pertinent sources of information.
- Establish productivity rates or perform task analyses.
- Calculate all applicable costs, including direct costs, indirect costs, contingency, and escalation (utilizing the schedule to calculate years for escalation).
- Produce all applicable detail and summary reports.
- Establish a funding profile utilizing the work breakdown structure and/or account code and time-phasing from the schedule.
- Determine what risks (and to what extent) should be mitigated with activities (or assumptions) in the cost estimate.
- Consider other inputs, including schedule information, risk management plan, and peer reviews, as appropriate.

Section 3.1.3 - Cost Estimate Documentation

A well-documented estimate will withstand scrutiny. If rigorous documentation and estimate procedures are followed, the credibility of a cost estimate increases. It is important to document all steps of the cost estimating process. The particulars of performing a cost estimate may vary, depending on local historical perspectives, professional judgment, available resources, and specific DOE program/field office requirements. As a minimum, the following items should be considered as cost estimate documentation:

Cost Estimate

A cost estimate should include elements for direct and indirect costs, contingency, and escalation. Detailed and summary estimate information should be arranged by a product-driven WBS or account and fiscal year within the period of performance. Information should be commensurate with available technical scope and include

- quantities,
- production rates,
- total labor hours,

-
- labor categories,
 - labor rates (typically including direct hourly labor rates, fringes, and labor burdens),
 - total labor costs,
 - material unit costs,
 - total material costs,
 - subcontract unit costs,
 - subcontract total costs, and
 - cost element (work package, activity, etc.) totals.

The estimate should be designed to be systematically replicated, checked, verified, or validated. Worksheets, calculations, and other pertinent documentation should be well organized. Documentation should contain the following.

- Description of discreet cost elements or activities to be completed within the scope of the project, including start-up costs, operating costs, and other life-cycle costs, as appropriate.
- Description of cost estimate techniques, quantities, and applicable rates
- Sources of information, such as historical costs, industry standards, published price lists, cost databases, informal budgetary information, cost estimating relationships, etc.
- Allowances, assumptions, and exclusions.
- Calculated contingency.
- Calculated escalation.
- Estimate history, or cost estimate log, if the cost estimate is a revision to an existing estimate or a change order estimate.
- The name, signature, and/or initials of the preparer and reviewer of the cost estimate.

Basis of Estimate

The basis of estimate documents the estimate assumption, exclusions, and criteria used in producing the estimate and should include

- cost estimate purpose and class;
- WBS, including deliverables and scope of work;
- code of accounts;
- project/program requirements and milestones, including constraints, special conditions, regulatory drivers, applicable DOE Orders, and industry standards;
- description of assumptions and exclusions;
- backup data, including quantity takeoffs, calculations, commercial databases;

-
- historical data, cost estimating relationships (CERs), quotes, and other general sources of information;
 - basis of direct costs (e.g., industry standards and historical information);
 - basis of indirect costs (e.g., rates from a corporate perspective);
 - basis of escalation; and
 - basis of contingency, which may include or reference a risk analysis or risk management plan.

Schedule

A project schedule is used to time-phase a cost estimate in order to calculate escalation, determine available resources, and establish budget requirements. A project's schedule should reflect activities in a cost estimate, but should also indicate project milestones, deliverables, and relationships between activities. Normally, schedules do not address productivity, sources of information, or contain indirect and overhead costs (and the associated indirect activities). A schedule should be included as a part of the cost estimate documentation.

Scheduling is an iterative process to cost estimating, scope development, and risk management. This direct relationship should be clear, concise, and easily understood by anyone reviewing the documentation.

Reconciliation

Reconciliation may be necessary to account for changes made between critical decisions or other life-cycle project milestones. Reconciliations should be organized by WBS and cover all aspects of project documentation (cost estimate, basis of estimate, schedule, and risks). In general, reconciliation should recognize or highlight specific changes in scope, basis of estimate, schedule, and risks. There should be an understanding that, as time progresses, more and better information is expected to be available and used as project or cost estimate documentation.

Reconciliations are necessary to mitigate budget shortfalls and may be used to correct deficiencies from internal or external reviews.

Section 3.2 - Cost Estimate Contents

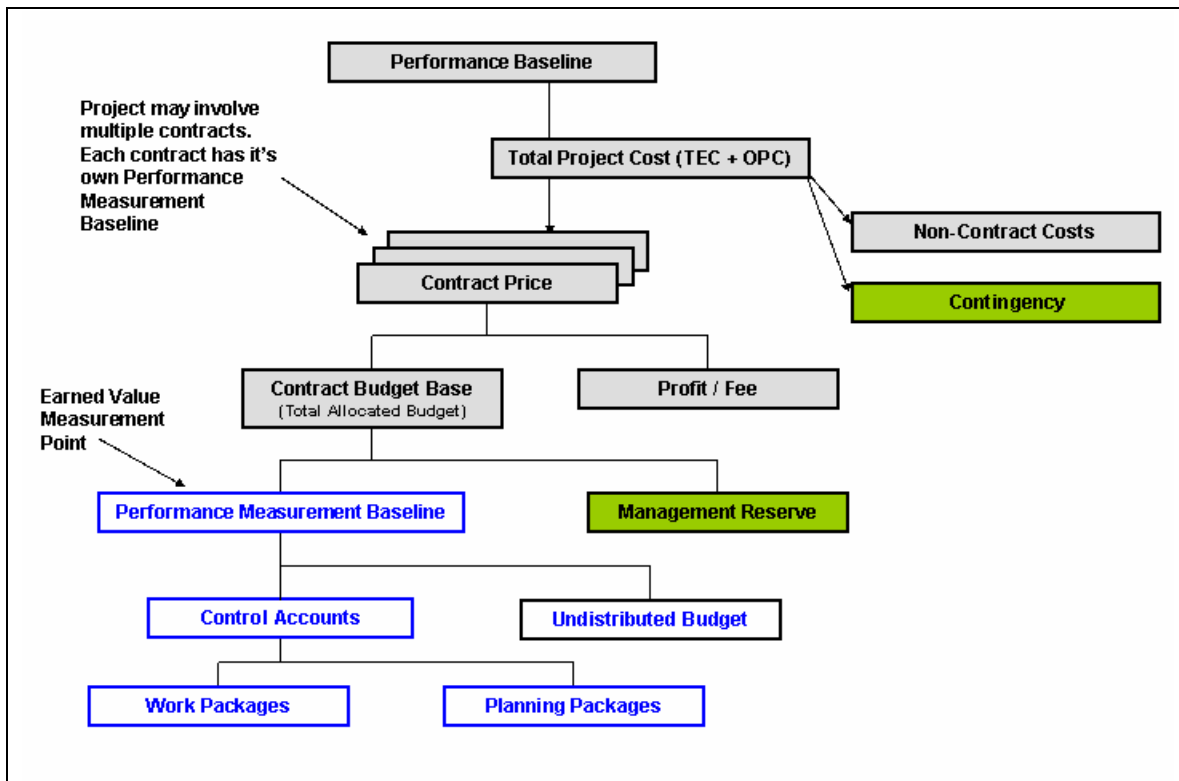
Cost estimates are normally organized by a WBS, a code of accounts, Work packages/planning packages, and/or other standardized code structures (e.g., Masterformat, Uniformat II, ECES), as applicable. However, there are sometimes project cost elements that are not standard, product-oriented, or easily defined in the context of a WBS or standardized code structure. Having set definitions for direct and indirect activities provides consistency in estimating costs and facilitates meaningful project reporting. This also benefits periodic program/project status reports, independent estimates (government estimates), reviews, contract/project validations, and cost/price analysis.

As work is authorized to proceed, these cost estimates become budgets. There is a distinction between budget allocations and cost estimates. Budget is used to execute

work.. (Also see Section 1.6, Terminology Relationships and Section 3.2.3 Contingency and Management Reserve.) Management Reserve is budget placed on contract.

Figure 3–2 depicts the contents of a performance baseline. A performance baseline consists of a projects' total project cost (TPC), including various contract prices, non-contract costs, and contingency.

Figure 3–2. Contents of a Performance Baseline (Project Budget Allocations)



3.2.1 - Cost Estimate Content Organization

A specific definition of items to be included as direct costs and indirect costs should be included at the discretion of the DOE program offices and DOE field offices and/or determined by their contractor's financial system; however, the following is provided as guidance.

The point of defining these here is to assure that there is no accounting overlap between items estimated as direct, indirect, or overhead costs. Generally, cost estimates include—

- direct costs,
- indirect costs,
- contingency, and
- escalation.

Cost estimates developed specifically to support budget formulation should include three specific categories of costs, as follows:

- Design Phase
 - Preliminary and Final Design
 - Design Management
 - Project Management
- Execution Phase
 - Land and Land Rights
 - Improvements to Land
 - Buildings
 - Special Equipment
 - Other Structures
 - Utilities
 - Standard Equipment
- Major Computer Items
- Removal Cost Less Salvage Value
- Inspection, Design, and Project Liaison
- Testing, Checkout, and Acceptance
- Construction Management Cost
- Project Management
- Contingency
 - Design Phase
 - Execution Phase



KEY POINT

Each activity in a project must be considered either a direct or an indirect cost. There should be a clear distinction between activities that are directly and those that are indirectly related to a project, with no duplication or overlap.

Regardless of this distinction, a cost can be considered either direct or indirect. Depending on the situation, site, program, or project-specific requirements or procedures, a direct cost at one site or for one project may not be direct at or for another. Careful analysis should be used in comparisons.

To the extent possible, this distinction should be consistently applied among projects for a DOE program, or at a DOE site.

ONE OR THE OTHER, BUT NOT BOTH!

Research and development, NEPA documentation, and operations and maintenance may be considered parts of an ongoing program and may be included in a project's costs, as appropriate.

The *DOE Budget Formulation Handbook* includes definitions used in both DOE's budget formulation and project management, and examples of project data sheets, used in submitting budgets.

DOE Budget Formulation Handbook, for FY 2005, may be found at <http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf>

Section 3.2.1 - Direct Costs

Direct costs include any costs that can be attributed solely to a particular project or activity, including labor, materials, subcontracts, equipment, salaries, and travel.

Emphasis is placed on the term *activity*, which typically in standard practice equates to a lowest WBS element, account code, work package, or planning package.

Commonly recognized direct costs include

- Construction labor, materials, equipment, subcontract costs, premium pay, and productivity adjustments, such as those for contamination or security restrictions.

Common construction activities include mobilization and de-mobilization, site work, concrete work, masonry work, etc.

- Operations labor, materials, equipment, subcontract costs, premium pay, and similar productivity adjustments, such as those for contamination or security restrictions.

Common operations activities include routine planning, monitoring, reporting, and meetings regarding a program's mission; warehouse operations, operating facility operations, administrative activities, research and development activities related to a programs mission, collaboration, travel, training, etc., but also may include such things as establishing a project prior to having an approved mission need, establishing an estimate of required PED funds, some preliminary design between CD-0 and CD-1, tie-ins to existing infrastructure, and start-up costs.

- Maintenance labor, materials, equipment, subcontract costs, premium pay, and similar productivity adjustments, such as those for contamination or security restrictions.

Common routine and preventive maintenance activities include minor facility repairs and/or upgrades, minor paving or landscaping, etc.

- Decontamination, decommissioning, dismantling, and demolition
- Project management
- Construction management
- Design, development, and start-up
- Security escorts and restrictions
- Special (capital) and standard (capital or non-capital) equipment
- Freight, packaging, and transportation
- Health physics support, radiological controls support, protective clothing/PPE, and industrial safety/health
- Sales and use taxes

Some items that may be included as direct costs as a part of a loaded labor rate include:

- Holiday and vacation pay
- Payroll taxes and insurance
- Fringe benefits or labor burdens
- Contract fee/profit

Allowances

In planning projects, it is normal to include allowances for activities for which there is little or no design basis, especially in the earliest stages. These are *not* considered contingency costs. Allowances should be included at the discretion of the project director, project manager, and IPT to cover anticipated costs associated with a known technical requirement or activity.

For instance, in a Class 5 cost estimate (order of magnitude), it would be appropriate to see a line item (cost account, or activity) such as “utility relocation, 1 lot, \$1M material and \$1M labor,” indicating that some utilities needed to be relocated as part of this project. Documentation supporting these costs should include approximate quantities, basis for those quantities, and source of the projected costs (e.g., consensus of the project team) proportional to the significance of the activity. Allowances also may be included in a project to cover costs associated with productivity adjustments, anticipated subcontract changes, anticipated design changes, and similar elements of known scope and costs.

Special Conditions

Consideration must be given to all factors that affect a project or program. Some of these factors are:

- Availability of skilled and experienced manpower and its productivity
- The need for overtime work
- The anticipated weather conditions during the period of performance
- Work in congested
- Work in radiation areas
- Security requirements imposed on the work area
- Use of respirators and special clothing

Special conditions may be estimated by applying a factor. For example, 10 percent applied to labor hours for loss of productivity due to work in a congested area. Other items may be calculated by performing a detailed takeoff. An example would be an activity that could only be performed over a two-day period. Overtime would be required to complete the activity and the number of hours and rates could be calculated.

Design Costs

To estimate design costs, the estimator must understand what activities are included. The following is a list of design-related activities.

- | | |
|--|---|
| • Preliminary and final design calculations and analyses | • Computer-Aided Drafting and computer services |
| • Preliminary and final plans and drawings | • A/E internal design coordination |
| • Outline specifications | • Design cost and schedule analyses and control |
| • Construction cost estimates | • Design progress reporting |

-
- Regulatory/code overview by A/E
 - Procurement and construction specifications
 - Surveys (surveying), topographic services, core borings, soil analyses, etc., to support design
 - Travel to support design
 - Reproduction during design
 - Design kickoff meeting
 - Constructability reviews
 - Safety reviews by A/E
 - Value engineering
 - Identification of long lead procurements
 - Design studies not included in Pre-Title I
 - Preliminary safety analysis report if not included in the conceptual Design Report
 - Design change control
 - Modification of existing safety analysis report
 - Design reviews (not third party)
 - Acceptance procedures
 - Certified engineering reports
 - Bid package preparation
 - Bid evaluation/opening/award
 - Inspection planning
 - Inspection services
 - Review shop drawings
 - Preparation of as-built drawings

Considerations for Estimating Design Costs

Design costs are directly related to the magnitude and complexity of a project and often range from 15 to 26 percent of the total construction cost. The following should be considered.

- | | | |
|---|-------------------------------------|--|
| • Comprehensive functional requirements | • Design reviews | • Labor density |
| • Quality level | • Safety analysis report | • Complexity |
| • Design planning | • Reports | • Overtime |
| • Design layout | • Government furnished equipment | • Adequacy of plans and specifications |
| • Engineering calculations | • Off-site architecture/engineering | • Off-site fabrications |
| • Drafting | • Inspections | • Travel and per-diem |
| • Specification preparation | • Schedule Analysis | • Guideline |
| • Project reviews | | • Performance specification |
| • Cost estimating | | |

Engineering Costs

Although these services may seem similar to conventional engineering, design, and inspection, there are several important differences that distinguish cleanup design from engineering design on other projects. These differences need to be underscored when estimating cost and schedule requirements. Major factors to be considered include the following:

The nature of the project

The regulatory process requires rigorous examination of design alternatives before the start of cleanup design, especially for remedial investigation/feasibility studies under CERCLA to support a record of decision (ROD) or for corrective measure studies under RCRA to support issuance of a permit. Cleanup design executes a design based on the method identified in the ROD or permit, which often narrows the scope of preliminary design and reduces the cost and schedule requirements.

The estimator should assess the extent to which design development is required or allowed in cleanup design. In some cases, the ROD or permit will be specific as for a disposal facility where all features such as liner systems and configuration, are fixed. When treatment options such as incineration are recommended, considerable design effort may be required.

Project requirements

Requirements for construction engineering, including observation, design of temporary facilities, quality control, testing, and documentation, will often be higher than for conventional construction because of requirements to comply with rigid regulations governing health and safety, quality assurance and other project requirements.

Construction Management Costs

A construction manager is responsible for construction activities, including coordination between prime contractors and subcontractors. This responsibility includes subcontracting, purchasing, scheduling, and a limited amount of actual construction. Generally, construction management costs are approximately 5 to 15 percent of the sum of the direct costs, indirect costs, and GFE, whose installation is under the direction of the construction manager.

Project Management

The estimate for project management must consider the time element from start of preliminary design through completion of the construction for the project. Other factors to consider are the complexity of the project, the design group, the organization for which the project is to be performed, and the extent of procured items. Projects involving travel must also include those costs. Typically, project management costs range from 2 to 5 percent of the TPC.

Construction Coordination

Construction coordination includes a field engineer. The field engineer should be involved in the review of the Title I and II documents, as well as the coordination of field construction. This function is generally estimated to be about .5%–1% of the construction costs.

Health and Safety

The review and approval of the design packages, safety audits, and health physics surveillance throughout the course of the construction period includes focus on health and safety. Factors are

- type of project
- operational area where the construction takes place
- amount of work requiring radiation surveillance
- other special health and safety requirements

The portion of health safety that is an audit function is not funded by construction and need not be included in the estimate. This is typically estimated by taking from 0.5 to 1 percent of the total construction costs for conventional projects, more for a remediation job.

Program Management

Activity management associated with environmental restoration parallels construction project management. However, when estimating activity management, consideration also must be given to program management services provided to the DOE for planning, organizing, directing, controlling, budgeting, and reporting on a program. Program management will be provided at multiple levels within the EM program, including the Headquarters, Operations Office, and installation.

Program management includes program support, which covers activities performed for internal management and technical support of the program by part-time or full-time personnel.

Considerations for Estimating Research and Development Costs

Traditionally, cost estimating involves the use of historical cost data to correlate and validate existing estimating methodologies. Historical cost data lends some accuracy and credibility to a cost estimate. When a cost estimate is required for new, innovative, state-of-the-art, first, or one-of-a-kind projects, historical data is not always helpful.

For these projects, knowledge of the processes involved will help the cost estimator in preparing an accurate/credible cost estimate. In the absence of accurate cost information, process knowledge can focus the estimator toward parts of the project that are significant contributors to overall project cost.

- ***Personnel Costs***

Personnel costs are usually the largest R&D expense. R&D personnel are well educated and have a higher pay scale than employees for conventional projects.

- ***Equipment Costs***

Equipment costs for R&D projects can be divided into hardware and software costs. Hardware includes machinery, computers, and other technical equipment. Equipment costs increase with increasing project complexity. For example, if the research involves extensive modeling or computer calculations, a supercomputer may be required. Specialized software may have to be developed for the project, so software costs can also be significant contributors to the overall project cost.

- ***Prototypes and Pilot Plants***

In some instances it will be cost effective to develop a prototype or a pilot plant for an R&D project. A cost estimate for a prototype or a pilot plant will have to account for the following:

- Construction of the equipment or plant
- Operation of the equipment
- Development of test criteria for plant studies
- Analysis of test results
- Computer simulation of plant processes

The estimate will also have to provide for project management and personnel during the pilot plant study or prototype testing.

- ***Scaled and Computer Models***

Scaled or computer-generated 3D models may need to be created for some projects. For example, if the project goal is to construct a new incinerator for mixed hazardous and radioactive waste, site-specific air dispersion modeling may be required to demonstrate that emissions from the incinerator will not have an adverse impact on public health or the environment.

Groundwater modeling may be required for some remediation sites. Assume the groundwater contamination has been found at a site, and several technologies are being proposed for the site. Modeling can be used to select the best technology or determine the optimum locations for equipment.

For conventional projects, finite element or seismic analysis may be used to determine potential weaknesses in a design. Some models can be quite complex and require specialized technical expertise on the part of the modeler to avoid the “garbage in = garbage out” phenomena. The labor hours required for input-data gathering, modeling time, labor, computer time, and report preparation must be accounted for in the cost estimate.

Regulatory Costs

Environmental and health and safety regulatory compliance costs are associated with all facilities and projects.

For conventional Government projects, the facility must satisfy all Federal, state, and local waste disposal, wastewater effluent disposal, and air emission limitations imposed

by the applicable Agencies. Regulations are even stricter for facilities that process or store radioactive materials. Construction sites must follow Occupational Safety and Health Administration rules.

Environmental projects must protect human health and the environment during all phases of the project. Cost estimates must contain sufficient provisions for environmental and health and safety compliance. A familiarity with applicable regulations is required so a plan may be developed and the project will comply with those regulations.

- ***Environmental Compliance Costs***

The number and requirements of environmental regulations have increased dramatically in the past 20 years. When preparing environmental compliance cost estimates, consider the following.

- type of project
- project location
- waste generation
- effluent characteristics
- air emissions

Location is significant to project cost when, for example, a wetlands area will be disturbed or the project is located in an area with extensive environmental regulations (California). Increased environmental compliance costs should be factored into projects in those locations.

Knowledgeable design staff and personnel familiar with area environmental regulations that will affect the project should be consulted when composing an estimate. Knowledge of wastes or air emissions generated during the project will facilitate the identification of environmental compliance design requirements and subsequent costs. For example, wastewater treatment may be required prior to effluent discharge into a stream or publicly owned treatment works. Air pollution control devices may be required for process equipment. Permitting costs could include

- labor for data gathering
- equipment for testing
- analytical tests
- time for interface with project personnel and outside consultants
- permit fees
- annual permitting costs
- upgrades to existing equipment
- new pollution control equipment

Once a plan for regulatory compliance has been established, the regulatory costs can be estimated. This will establish a baseline for the costs and regulatory changes that affect this baseline can be tracked and estimated throughout the project's life.

- ***Health and Safety Compliance Costs***

Employee health and safety regulations have followed the same general trends as environmental regulations toward increased regulation. As allowable limits for worker exposure decrease, design cost estimates will have to account for specific engineering controls to minimize employee exposures to toxic or hazardous substances in the workplace, especially for facilities involved with radioactive materials.

- Past experience with increased regulatory rigor within DOE has shown that the costs associated with employee workspace controls, including industrial hygiene monitoring, is the most significant cost factor in a more rigorous health and safety program. The trend will probably continue.
- Planning is essential because retrofit costs can exceed original installment costs. State-of-the-art, high-tech facilities may require initial employee exposure monitoring if unknown factors are encountered. Protective equipment must also be supplied and maintained for the employee.
- Environmental projects may have strict health and safety requirements, including routine medical surveillance, preparation of health and safety plans, and employee training. Employees may not be able to work 8 hours a day if daily personnel and equipment decontamination is mandatory. Compliance Costs and Scheduling
- For some projects, a permit is required before work can commence. For example, construction projects that will disturb more than 5 acres are required to obtain a storm water permit before commencing construction. Project scheduling can be affected if operating permits are not received in a timely manner. Facilities may be shut down for violations of operating permits or failure to comply with existing regulations. The time required for regulatory review of the permit application also must be factored into the cost estimate.

Specialty Equipment Costs

Atypical hardware or equipment such as glove boxes for radioactive handling or architectural specifications such as computer room floors or flag poles are not common to conventional projects. In most cases, however, a good cost estimate can be developed with the help of vendor quotes.

Computerized modeling may be required as part of the permit process, and any estimate for the project should include cost for outside consultants' modeling and report preparation.

Non-Contract Costs

Other DOE-direct costs should be included, as appropriate. Where activities and productivity for operations are concerned, costs should be calculated appropriately.

Although level-of-effort cost estimates are normal (based on FTEs per year, etc.), it is still appropriate to consider activities and productivity. These costs are not automatically recognized by a contractor as pertinent, but should be included to portray a TPC, performance baseline, or a project's total life-cycle costs, as appropriate.

Section 3.2.2 - Indirect Costs

Indirect costs are incurred by an organization for common or joint objectives that cannot be specifically identified with a particular activity or project. Depending on the contract types and circumstances, these indirect costs may include programmatic or functional costs, such as comprehensive planning, security, procurement, engineering, project controls, cost estimating, or research and development. They may also include a contract's general and administrative costs (G&A).

Indirect costs are—

- facilities, operating equipment, small tools, and general maintenance;
- temporary facilities (e.g., water, compressed air, and power);
- motor pool, camp, and aircraft operations;
- warehousing, transfer, and relocation;
- safety, medical, and first aid;
- security;
- administration, accounting, procurement, and legal;
- personnel expenses, office supplies, and time reporting
- permits and licenses;
- contributions to welfare plans and signup/termination pay; and
- contract fee/profit, bonds costs (performance and material payment).

A summary of site indirect costs may be found at the FMSIC website:

<http://www.mbe.doe.gov/progliaison/festrpt/FY01fscr.pdf>

Section 3.2.3 - Contingency and Management Reserve

Contingency is often misunderstood. The purpose of this section is to improve the understanding, consistency, and use of contingency. This section also will define a clear distinction between contingency and management reserve.

Cost for *contingency* is added to estimates in preparation for undefined future events within scope of a project or specific endeavor but not part of the negotiated contract. Because contingency is not put on contract, it is controlled by the Government and cannot be developed through detailed estimate. If it were possible to estimate a cost in detail, it would become part of the project scope and would not be considered a contingency.

Contingency is a response to the uncertainty inherent in many highly complex projects. This uncertainty is the risk that an event will transpire within the scope of a project, which cannot be planned, estimated or controlled with any certainty. The initial response

to this uncertainty plans to reduce or eliminate risks. Budget allocated for this planning is not contingency, but part of the project budget. The plan includes work packages that can be estimated, scheduled, and managed.

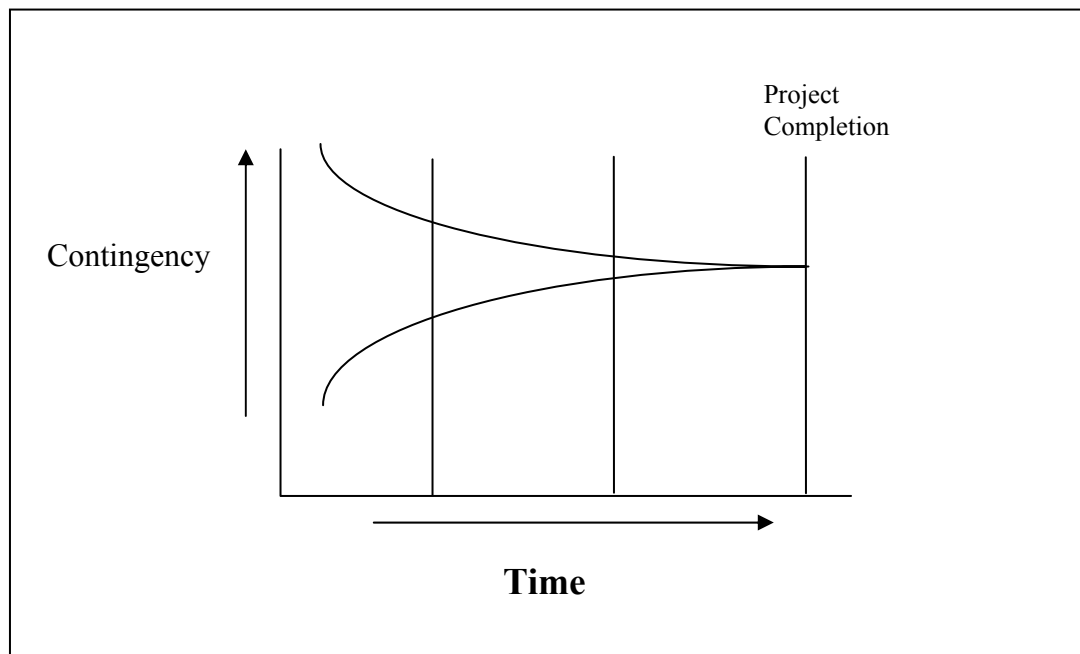
Contingency is not an alternative to risk management where every effort is made to eliminate unknowns and manage risks. Even when the risk management plan will encompass most or all of the identified risks, there remains in every project some uncertainty that cannot be quantified with any accuracy without the benefit of supporting data from previous efforts to serve as basis for modeling uncertainty. In the absence of supporting data, uncertainty must still be accommodated in project estimates.

Contingency varies based on the type, size, duration, and complexity of a project. DOE no longer provides or advocates the use of tables once available to project estimators to calculate contingency.

Supporting data should be assessed and collected formally, creating useful methods and models to be used in project assessments of contingency. Until this data is captured formally, it cannot be quantified or modeled. Contractors should endeavor to capture and use completed project cost information to develop cost estimating relationships (CERs), which subsequently may be used in estimating, as available and appropriate. Several organizations (including those sponsored by the Federal government) have guidance on collecting historical cost information, creating CERs, and preparing parametric cost estimates.

The application of contingency encompasses the entire life cycle of a project. As illustrated in Figure 3-4, contingency requirements decline as projects mature.

Figure 3–3. Contingency over the project life cycle



This declining need for contingency will be the result of two factors in the development of most projects. The first factor project maturity when as time passes, the unknowns, uncertainty, and risks will decrease. If they are not decreasing then the project may not be

maturing sufficiently. The second factor declining need for contingency planning. The greatest need for contingency is early in the project lifecycle where planning, development, and design process resolves the uncertainty and unknowns. Consequently, uncertainty will usually decrease rapidly because of the maturation process and the application of contingency until the need for contingency approaches zero as the project nears completion.

Determining Contingency

Contingency should be determined by evaluating the need based on risks and uncertainty and estimating requirements to implement a recovery plan, should the unexpected occur. Statistical modeling can then be employed to provide a check of the estimate. Confidence in the contingency budget increases when there is agreement between estimates derived through analysis and those derived through simulation. Where there is disagreement, the project team must analyze the data to determine if there is excessive error in the model or a discrepancy in the analysis that was used to determine the contingency budget. Some conditions that will affect the need and amount of contingency budget are

- Effectiveness of risk mitigation strategies being accomplished (risk planning/mitigation strategies included in a projects scope)
- Past performance of similar projects
- Contractor capabilities
- Technology and reliability requirements
- Security
- Contamination or environmental or site conditions (weather, terrain, location)
- Scheduling, especially to meet critical milestones
- Construction constraints
- Other items unique to the project, such as nuclear and waste management permits and reviews



KEY POINT

Contingency is a normal component of a project's costs and is to be included in estimates during the budgeting process, commensurate with project risks.

Management Reserve

Management reserve is an amount of the *total allocated budget* withheld for *management control purposes*. Because management reserve is part of the contract budget base (CBB), it is controlled by a contractor. A contractor (or supplier), whether a prime contractor or a subcontractor, may choose to employ reserves by allocating budget to specific work packages or work breakdown structure elements that is less than the estimate. The remaining budget is held as reserve and the contractor manages the effort to the established performance measurement baseline, in order to enhance performance,

anticipate increased performance, or otherwise allow for anticipated day-to-day management efficiencies. The Government does not control but must approve the performance measurement baseline and by association management reserve. Management reserves are not funds. Rather they are part of the allocated budget. When the contract is a cost contract, the Government will have insight into the allocation and utilization of management reserve. In a competitive fixed-price environment, the Government usually will not have access to the management reserve information.

Buried Contingency

Typically, it is *not* sound business or professional practice to overstate anticipated costs, or to *bury contingency*. Padded estimates are likely to surface during analysis and reviews and may be viewed as lack of a sound basis for estimates. If there is a basis for an expected cost, including managing risks, it should be part of the estimate. Estimators should refrain from burying contingency or unnecessary allowances and be should carefully remove any such data from the estimate.

Buried contingency has been identified in many ways. Data that may invite scrutiny include

- unjustified increase in quantities, affecting materials, labor, and equipment costs
- unjustified increase in crew sizes or necessary FTEs affecting labor rates and total labor costs
- unjustified decrease in productivity anticipated (productivity factors), affecting labor and equipment hours and costs
- unjustified increase in accounting for waste and scrap, affecting labor and material costs

Confidence Levels

Given that business decisions are often uncertain, DOE demands that project decisions be characterized by high confidence level. There is simply so much at stake. Because of the added amount time and money; increased planning, analysis, and review to be conducted; and the subject nature of assigning confidence levels to projects, DOE does not will not require a that a percentage level of confidence be attained.



KEY POINT

Management reserve is budget set aside by the contractor and under the contractor's control.

An experienced cost estimator, project manager, and project team can generate high confidence levels in the least amount of time, effort, or dollars expended and instinctively know when confidence is high. A high' confidence level is a function of objective and subjective criteria and typically reflects the proper level of planning, analysis, and review. Confidence levels should be *directly proportional* to the project phase, size and complexity,

and information supporting the decision and should be *indirectly proportional* to the speed that is required to make the decision. When percent confidence required is correctly correlated with the aforementioned factors, expended resources are optimized. Contingency analysis—communicating how one arrives at a given confidence level, including consideration of risk management planning and mitigation strategies—is imperative.

Contingency should ensure successful project completion!

More information on parametric cost estimates and the Parametric Estimating Initiative (PEI) Parametric Estimating Handbook can be found through the International Society of Parametric Analysts (ISPA), at

<http://www.ispa-cost.org/>

More information on cost estimating and analysis can be found through the Society for Cost Estimating and Analysis (SCEA), at

<http://www.sceaonline.net/>

More information on cost engineering can be found through the Association for the Advancement of Cost Engineering, International (AACE), at

<http://www.aacei.org/>

Section 3.2.4 - Escalation

Costs change continuously following changes in

- technology
- availability of resources
- value of money (e.g., inflation)

Historical cost indices and *forecasted escalation indices* have been developed to document and forecast changing costs. The use of an established escalation index is required to consistently forecast future project costs. To ensure proper use of an index, one must understand its bases and method of development.

Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor affected by continuing price changes over time. Escalation may be

- forecasted, to estimate the future cost of a project based on current year costs or
- historical, to convert a known historical cost to the present.

Although the forecasted and historical escalation rates may be used in succession, most cost estimating is done in current dollars and then escalated to the time when the project will be completed. This section discusses the use and calculation of escalation and historical cost indices. An example of the calculation and use of escalation can be found in AppendixE.

Forecasted Escalation Rates

Forecast escalation rates are obtained from commercial forecasting services, such as Global Insight (formerly DRI-WEFA), which supplies its most current predictions using an econometric model of the United States economy. The forecasted escalation index is

the ratio of the future value to the current value expressed as a decimal.

Forecast escalation rates are simply the percentage change from one year to the next, typically prepared for various groups, utilizing different sources of data. For example, the forecast escalation indices for construction may contrast with the one for environmental restoration, because the “market basket-of-goods” is so different. Annual escalation rates are recommended by OECM, through the annual budget formulation guidance, to the DOE program offices and DOE field offices.

Because the duration of larger projects extends over several years, it is necessary to have a method of predicting funds that must be made available in the future. This is where forecasted escalation rates are used. The current year cost estimate is divided into components and then multiplied by the appropriate escalation rate to produce an estimate of the future cost of the component. The future costs of these components are then summed to give the total cost of the project.

To properly apply escalation, the following data is required:

- reference date the estimate was prepared and base date of costs
- escalation index, or cumulative rates, to be used (including issue date and index)
- schedule, with start and completion dates of scheduled activities

Escalation should be applied for the period from the date the estimate was prepared to the midpoint of the performance schedule or the activity being escalated. There are many more detailed methods of calculating escalation, but care should be taken to not make this calculation too complex. Remember, someone external to the project may need to review this calculation. Regardless of the method used, the process should be well documented.

“Which comes first, contingency or escalation?” If a project includes a contingency that is based on risks, and those risks have associated costs, this may imply use of the same base-year dollars. And generally, performance periods can be associated with those risks within components, so, escalation may be applied to contingency. However, if contingency is not easily discernable by WBS element (or cost elements) or cannot be associated with a time period, it may not be appropriate to escalate contingency. *The cost estimate should ultimately represent total escalated costs, or “then-year dollars.”*



KEY POINT

- Several different methods may be used to calculate escalation, including the use of a specific project spending curve.
- Escalation should be included at a level appropriate for the size and complexity of the project.

Historical Escalation

Historical escalation is generally easily evaluated. For example, the cost of concrete changed between 1981 and 2002. The ratio of the two costs expressed as a percentage is the historical escalation rate, or expressed as a decimal number is the historical cost index. Several commercially available Historical cost indices are available.

To properly apply a historical cost index to make price more current, the following data is required—

- The prior cost or price, with a reference date, such as an actual price for a known project or a component. This cost or price may include direct material and/or labor cost, and it should be known to what extent indirect costs (sales taxes, freight, labor burden, etc.), overheads, and profit were included.
- An applicable historical cost index.

Current escalation rates may be found at the DOE-CEG website, or in the current years' DOE Budget Formulation Handbook. When rates used are other than those provided as guidance, supporting documentation should be provided or referenced in the basis of estimate. More specific guidance regarding the use and application of escalation may be provided by the DOE program or field office. Table 3-4 contains the current DOE escalation rate assumptions for projects.

**Table 3-4. Escalation Rate Assumptions for DOE Projects
(January 2004)**

Project Categories										
	Construction		EM		IT		O&M		R&D	
FY	Index	%	Index	Rate	Index	Rate	Index	Rate	Index	Rate
2002	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-
2003	1.021	2.1	1.020	2.0	1.008	0.8	1.018	1.8	1.023	2.3
2004	1.046	2.5	1.047	2.7	1.017	0.9	1.045	2.6	1.051	2.8
2005	1.076	2/9	1.075	2.7	1.022	0.5	1.073	2.7	1.080	2.7
2006	1.106	2.8	1.103	2.6	1.032	1.0	1.101	2.6	1.108	2.6
2007	1.135	2.6	1.130	2.4	1.041	0.8	1.127	2.4	1.136	2.5
2008	1.164	2.6	1.157	2.4	1.049	0.8	1.154	2.4	1.164	2.5
2009	1.194	2.6	1.185	2.4	1.057	0.8	1.182	2.4	1.193	2.5

This table can be found at

http://oecm.energy.gov/cost_estimating/2004Rates.pdf

Section 3.3 - Reviews

The third step in the cost estimating process is review for quality aspects before release. There are at least four types of reviews, design and constructability review; peer review, which include assessment of the estimating department or project team; internal review, where internal means within a DOE project, program, or DOE field/site office; and external review, where external means outside a DOE project, program, or DOE field/site

office and where findings are addressed formally and corrections are made as formal corrective actions.

Reviews are either objective or subjective.

Objective reviews take a very structured approach using checklists and grading systems, which address consistency of projects estimated or procedures followed. Objective reviews may also indicate a minimum acceptable level of quality.

Subjective reviews are less structured and may address areas differently, depending on various levels of emphasis. Internal reviews may combine objective and subjective criteria but should be performed consistently between projects within a program to the most practical extent.

As a minimum, *all* estimate should address the review criteria listed in Appendix E.

Section 3.3.1 - Design and Constructability Reviews

Design and constructability reviews are essential in capturing all activities and resources required to complete a project successfully. Each DOE field or site office should ensure that projects are designed efficiently and effectively, and that when design is complete, the project can actually be built or executed as designed. These reviews also are valuable in establishing risks to be encountered, which normally need to be addressed in a project's risk management plan.

Section 3.3.2 - Peer Reviews

Peer reviews are cost estimate reviews conducted internally within a department or by a DOE contractor before submission to DOE for review or official use. Peer reviews may be objective or subjective, formal or informal, and written or oral but for more complex projects, should be documented. As the name implies, peer reviews are performed by cost estimating peers or those that work with the cost estimators, a project team, a design group, a cost estimating department or manager, or an array of individuals that can provide feedback to the cost estimator before a cost estimate is released. These reviews should prepare the cost estimate for further scrutiny.

Section 3.3.3 - Internal Reviews

Internal reviews, sometimes be referred to as independent project reviews initiated by a DOE program office or reasonableness reviews initiated by a DOE site or field office (budget validation). internal reviews are well-documented and can be good sources of fact-finding for external and other reviews.

Section 3.3.4 - External Reviews

External reviews are not so much a step in the cost estimating process as they are a project responsibility. Review is conducted outside the cognizance of estimator (DOE program or field office). The review is a quality assessment performed to answer questions from Congress and other interests outside the responsible DOE program. External reviews are a part of cost estimating guidance because (per LCAM and

DOE O 413.3) it is a DOE field program, site and field office, and contractor responsibility to coordinate and facilitate these reviews. Specifically, external independent reviews (EIRs) are mandated by Congress on specific projects. An EIR guide is available from OECM.

External reviews may be both objective (checklists or other specific criteria) and subjective (informal criteria). Criteria used for external reviews are based on the types of information, the purpose, and time available. Because there are various reviewers, purposes, and types of projects to be reviewed, each review is normally specific to a project or program.

More information on external independent reviews may be found at http://oecm.energy.gov/project_reviews/EIR_Standard_Operating_Procedures_October_2003%20final_2.pdf

CHAPTER 4 - COST ESTIMATING OUTPUTS

SECTION 4.1 - COST ESTIMATE INTERFACES

SECTION 4.2 - BASELINES AND CHANGE CONTROL

SECTION 4.3 - ANALYSIS

CHAPTER 4, COST ESTIMATING OUTPUTS, defines traditional output as shown in. These are often specifically defined cost estimates as is, for instance, the critical decision process. Otherwise, outputs include the traditional change control process, economic and cost-benefit analysis, value engineering, earned value, and final project cost reports.

Some terms used in this chapter include:

- Baseline
- Change control
- Analysis
- Value engineering
- Estimates at completion

Figure 4–3. Cost Estimating Process



Section 4.1 - Cost Estimate Interfaces

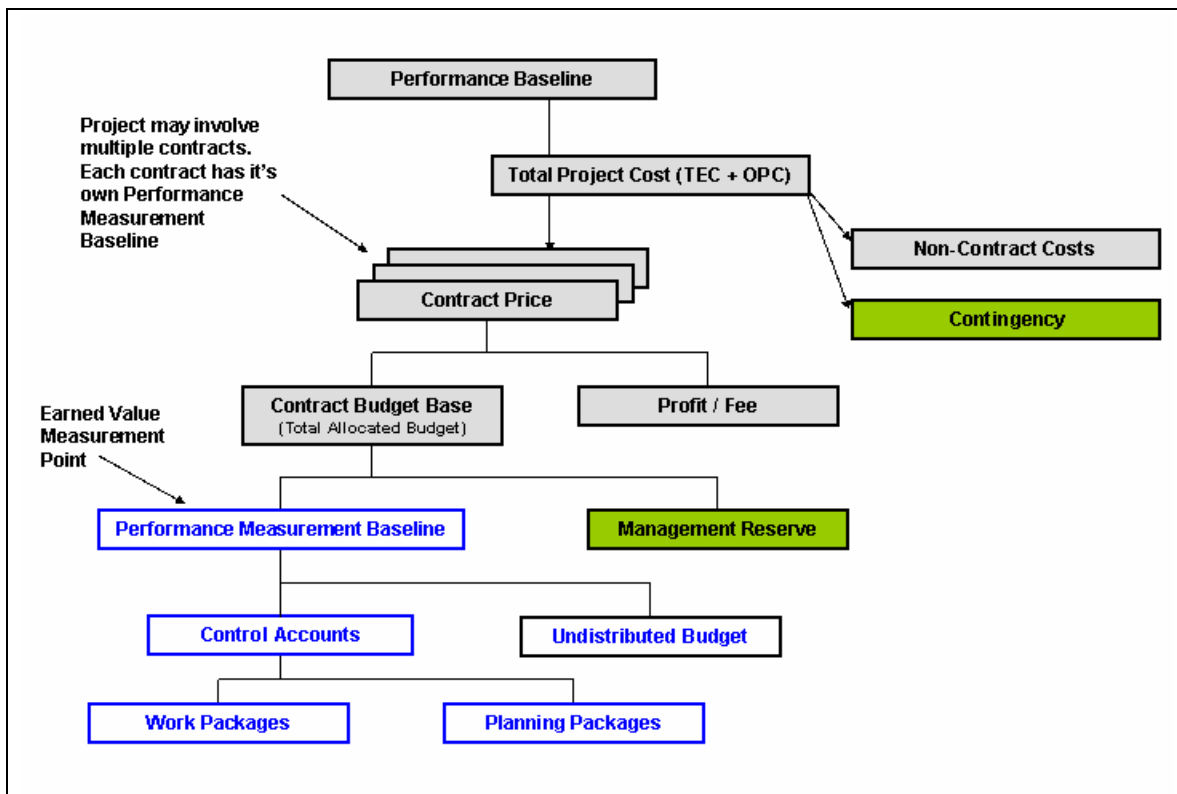
Cost estimate development is initiated into a process through inputs to the process. These inputs are either one-time or iterative. One-time inputs may include (but are not limited to) the project charter, project execution plan, acquisition strategy, and acquisition plan. All of these are inputs to the cost estimating process, but they will not necessarily evolve through the cost estimating process.

Other inputs may evolve through the cost estimating process, such as the risk assessment (primarily risk identification), schedule, and scope development. Peer reviews, too, are iterative. Input to or by cost estimating peers may impact the quality of the cost estimate, and peer reviews should be required before external reviews are conducted.

Section 4.2 - Baselines and Change Control

Cost estimates are normally organized by a WBS, account code, and/or some other standardized definition (e.g., CSI divisions). Standard definitions of direct and indirect costs provide consistency in estimating costs and project reporting. This also benefits program/project management, independent estimates (Government estimates), reviews, and contract/project validations and cost/price analysis. Figure 4–4 depicts the contents of a performance baseline. The cost portion of the performance baseline consists of a projects' TPC, including various contract prices, non-contract costs, and contingency.

Figure 4–4. Contents of a Performance Baseline (Project Budget Allocations)



As projects evolve, they become baselines and changes are managed against those baselines. Cost estimates supporting proposed or directed changes should contain the same level of quality as the primary baseline cost estimate.

Baselines are expected to remain intact through the remainder of the project (from CD-2). Changes are expected, but they should remain within the performance baseline. If a project encounters a situation where the performance baseline is breached, the project is said to have a *deviation*. When projects expect a deviation, they are required to assess corrective actions and establish a plan for correction or obtaining approval, similar to other previous critical decisions.

Section 4.3 - Analysis

Analysis includes decomposition and examination. In many cases, analysis will provide insight to a decision maker. Such is the case of cost-benefit analysis. Cost-benefit

analysis is a required element in capital planning within the Federal government. If a project's costs exceed benefits (quantitative and qualitative), the Government probably should not be doing it. The analysis should contribute to the determination of feasibility or efficacy of a project.

In the contracting community, cost analysis or price analysis is a comparison of either costs or price, respectively (e.g., a proposal to a government estimate). If a contract is competitively bid, cost analysis (which is more detailed and complex than price analysis) may not be required.

However, many analyses are performed in the life of a project. Some related terms, some used synonymously, are

- *Cost-benefit analysis*—the systematic, quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects.
- *Cost-effective analysis*—appropriate when it is unnecessary or impractical to consider the dollar value of the benefits provided by the alternatives under consideration when
 - each alternative has the same annual benefits expressed in monetary terms or
 - each alternative has the same annual effects, but dollar values cannot be assigned to their benefits.

Analysis of alternative defense systems often falls into this category.

Cost-effective analysis can also be used to compare projects with identical costs but differing benefits. In this case, the decision criterion is the discounted present value of benefits. The alternative program with the largest benefits would normally be favored.

- *Economic analysis*—considers all costs and benefits (expenses and revenues) of a project, considering various economic assumptions made, such as inflation and discount rates.
- *Life-cycle cost analysis*—considers all costs (capital, operating, and decommissioning expenses for the duration of a project) for various alternative approaches, including inflation and discount rates.
- *Sensitivity analysis*—considers all activities associated with one cost estimate. If a cost estimate can be sorted by total activity cost, unit cost, or quantity, sensitivity analyses can determine which activities are “cost drivers” to answer the question, “If something varies, what most affects the total cost of the project?”
- *Uncertainty analysis*—considers all activities associated with one cost estimate and their associated risks. An uncertainty analysis may also be considered part of a risk analysis or risk assessment.
- *Other types of analysis* are performed throughout the life of most projects. Some analyses are highly structured and formal, while others are loosely structured and informal. Analyses supporting critical decisions should be structured and formal—that is, well-documented.

Normally, analyses require using similar cost estimate structures (separate cost estimates for each alternative considered); having all costs for all alternatives depicted as either present worth or annuities; and comparing alternatives using net present value or annuities. Normally a written summary of the findings is also prepared to explain the analysis.

More information on parametric cost estimates, including the Parametric Estimating Initiative (PEI) Parametric Estimating Handbook, can be found through the International Society of Parametric Analysts (ISPA), at

<http://www.ispa-cost.org/>

More information on cost estimating and analysis can be found through the Society for Cost Estimating and Analysis (SCEA), at

<http://www.sceaonline.net/>

More information on cost engineering can be found through the Association for the Advancement of Cost Engineering, International (AACE), at

<http://www.aacei.org/>

CHAPTER 5 - COST ESTIMATING EXPECTATIONS

SECTION 5.1 - SUMMARY OF EXPECTATIONS

SECTION 5.2 – TREND ANALYSIS

SECTION 5.3 - BENCHMARKING

SECTION 5.4 - HISTORICAL COST INFORMATION

SECTION 5.5 - LESSONS LEARNED

CHAPTER 5, COST ESTIMATING EXPECTATIONS will explain what is expected from the use of DOE cost estimates.

Some terms and concepts used in this chapter are:

- Review criteria
- Trending
- Benchmarking
- Historical cost information
- Lessons learned

Section 5.1 - Summary of Expectations

Several different adjectives may be used to describe *what is expected* of DOE cost estimates. A cost estimate, regardless of purpose, classification, or technique employed, is expected to maintain quality or status that would infer that it is appropriate for its intended use, has been completed appropriately, and has survived some *internal* checks and balances. It should also be clear, concise, reliable, fair, reasonable, and accurate (within some probability or confidence levels). There could be more, depending on the program, project, contract type, specific budget requirements, or other situations.

Common elements of cost estimates are expected to be constant. For instance, *all* cost estimates generally should meet the following criteria.

- Be organized by a work breakdown structure (WBS)
- Be based on a specific scope of work (SOW)
- Include all direct and indirect costs, appropriately
- Include escalation based on the schedule, appropriately
- Include contingency to assure project success or to reflect some confidence level
- Use appropriate cost estimating techniques
- Include appropriate cost estimate documentation
- Consider previous cost estimate versions, appropriately
- Include life-cycle costs, appropriately
- Be produced by qualified cost estimators

Review criteria are described in more detail in Section 3.3, Reviews, and are listed in Appendix E for easy reference.

Other expectations include various sorts of organization. Examples include resource, organization, code of accounts, or another similar coding structure appropriate for the type of work represented by the cost estimate. These codes facilitate project management and earned value systems and can provide extremely useful information as projects are completed. Industry standard codes are exemplified by the construction specifications Institute's Unifomat II and Masterformat, for construction-type projects. Other code structures include the environmental cost element structure (ECES), an ASTM standard for environmental projects. Some of these industry standard codes are listed in the appendices.

Other formats, such as project data sheets (PDSs) for budget formulation, should be produced, as necessary.

More information on the Unifomat II can be found at <http://www.unifomat.com/background.html>

More information on the Masterformat can be found at <http://www.csinet.org/technic/mflite.htm>

More information on the ECES can be found at <http://www.em.doe.gov/cost/eces.html>

More information on DOE Budget Formulation, with examples of project data sheets, can be found at <http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf>

More information on OMB's Exhibit 300 forms can be found in OMB A-11, Part 7 at <http://www.whitehouse.gov/omb/circulars/a11/2002/part7.pdf>

Section 5.2 - Trend Analysis

Trend analysis is used to explain quantitatively how a project is progressing. Performance measurement, or earned value data, is another way to explain project progress. *Trending* is especially useful when large quantities of material are the objective of a project, (e.g., mass excavations measured in cubic yards or cubic meters; mass concrete construction placement measured in cubic yards or cubic meters; structural steel fabrication/installation measured in tons). For instance, periodic *trend analysis* uses a project's actual costs to date, per the total number of units produced, to provide a report of current costs per unit. Variations, up and down, from previous periodic trending information can help a project with decisions regarding resources (people, equipment, etc.) and near-term planning adjustments.

Section 5.3 - Benchmarking

Benchmarking is a way to establish commercial norms and expectations, heuristics, or rules-of-thumb. Benchmarks are categorized and may be useful when other means of establishing reasonable estimates are unavailable.

An example of a benchmark is the statistic indicating that *design should be 6 percent of construction cost*. If you can calculate construction costs (even approximately) using a

parametric technique, design should be approximately 6 percent. There are many benchmarks.

- Large equipment installation costs should be x% of the cost of the equipment
- Process piping costs should be x% of the process equipment costs
- Commercial types of work (brick and mortar, construction) should cost approximately that of current, local, commercial work at DOE facilities (using industry standard publications, etc.)

Benchmark information is contained in Appendix I. These benchmarks will be updated periodically to reflect current information.

Section 5.4 - Historical Cost Information

Historical cost information can be depicted as lump sum (representing some specific scope of work), unit cost, or productivity (hours per unit, or units per hour). With each element or activity, materials, labor, equipment, and other costs should be addressed or at least recognized for future use. Normally there are *parameters* with which to establish unit rates; however, where there are many parameters, some may be acknowledged as *secondary parameters*. The use of parameters in estimating future projects is the essence of the parametric cost estimating technique.

Historical costs should be provided to DOE for analysis, normalization, and use in future project cost estimates.

At the completion of a project, the final costs should be collected and submitted to DOE for analysis and use as historical cost information. Analysis of historical cost data should include some form of *data normalization*, which brings all data to some common understanding, whether local (to be used with location adjustment factors), current (to be used with standard historical cost indices), or another adjusting method. A statement of a project's final cost should be made as a part of the projects completion report, lessons learned reports, and other cost/performance reports.

Section 5.5 - Lessons Learned

Lessons learned from experience are essential to structuring establishing systematic processes and procedures. It can make information retrieval relatively easy and useable. Lessons learned from a project should be planned for and collected, rather than done last-minute or by trying to look back to recollect.

Lessons learned that can help cost estimators with future cost estimates may be generic in nature or specific to a site, location, contract type, etc. They may apply to a particular scope of work or a cost estimating technique. There are many ways to communicate lessons learned. The point is to document what you've learned from the experience and share it with others, as appropriate.

Information on DOE's lessons learned can be obtained at <http://www.tis.eh.doe.gov/ll/index.html>

Information on Best Practices established by DOE's Energy Facility Contractors Group (EFCOG) can be obtained at

<http://efcog.org/Best%20Practices/Best%20Practices.htm>

Information on DOE's Environmental Management Cost Estimating and Validation
Lessons Learned Workshops can be obtained at

<http://www.em.doe.gov/aceteam/training.html>

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APPENDIX B - DEFINITIONS

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APPENDIX K - BIBLIOGRAPHY

APPENDIX A - ACRONYMS

A/E	architect/engineer
AACE	Association for the Advancement of Cost Engineering, International
ABC	activity-based costing
ANSI	American National Standards Institute
AS	acquisition strategy
ASTM	American Society for Testing Materials
BOE	basis of estimate
CD	critical decision
CDR	conceptual design report
CER	cost estimating relationship
CFO	Chief Financial Officer
CFR	Code of Federal Regulations
CM	construction management
COA	code of accounts
CPAF	cost plus award fee (contract type)
CPFF	cost plus fixed fee (contract type)
CPI	cost performance index
CPIF	cost plus incentive fee (contract type)
CSI	Construction Specifications Institute
DOE	Department of Energy
EIR	external independent review
ESAAB	Energy System Acquisition Advisory Board
ES&H	Office of Environment, Safety, and Health
FP	fixed-price (contract type)
FTE	full-time equivalents
GFE	Government-furnished equipment
GPP	general plant project
ICE	independent cost estimate
ICR	independent cost review
IPT	integrated project team
ISMS	Integrated Safety Management System
IT	information technology
LCCA	life-cycle cost analysis

LOE	level of effort
MR	management reserve
MS	major system
NPV	net present value
OMB	Office of Management and Budget
OPEX	operating expense
PB	performance baseline
PD	project director
PDS	project data sheet
PED	project engineering design
PEP	project execution plan
PM	project management or contractor project manager
PMB	performance measurement baseline
QA	quality assurance
R&D	research and development
SPI	schedule performance index
SOW	statement of work
SV	schedule variance
TEC	total estimated cost
TPC	total project cost
UB	undistributed budget
VE	value engineering
WBS	work breakdown structure

APPENDIX B - DEFINITIONS

Acquisition strategy (AS)—a business and technical management approach designed to achieve acquisition objectives within the resource constraints; the framework for planning, directing, contracting, and managing a system, program, or project; a master schedule for research, development, test, production, construction, modification, postproduction management, and other activities essential for success; the basis for formulating functional plans and strategies (e.g., acquisition strategy, competition, systems engineering). Once approved, the AS should reflect the approving authority's decisions on all major aspects of the contemplated acquisition. (DOE PM Manual)

Activity-based costing (ABC)—

- costing using a method to ensure that the budgeted amounts in an account truly represent all the resources consumed by the activity or item represented in the account. (AACE)
- cost estimating in which the project is divided into activities and an estimate is prepared for each activity. Also used with detailed, unit cost, or activity-based cost estimating.

Allowance—an amount included in a base cost estimate to cover known but undefined requirements for a control account, work package, or planning package.

Analysis—separation of a whole (project) into parts; examination of a complex entity, its elements, and their relationships; a statement of such analysis.

Baseline—a quantitative definition of cost, schedule, and technical performance that serves as a standard for measurement and control during the performance of an activity; the established plan against which the status of resources and the effort of the overall program, field programs, projects, tasks, or subtasks are measured, assessed, and controlled. Once established, baselines are subject to change control discipline.

Basis (basis of estimate, or BOE)—documentation that describes how an estimate, schedule, or other plan component was developed, and defines the information used in support of development. A basis document commonly includes a description of the scope, methodologies, references and defining deliverables, assumptions and exclusions, clarifications, adjustments, and level of uncertainty. (AACE)

Benchmark—standard by which performance may be measured.

Budgeting—a process for allocating estimated of resource costs into accounts (i.e., the cost budget) against which cost performance will be measured and assessed. Budgeting often considers time-phasing in relation to a schedule or time-based financial requirements and constraints. (AACE)

Buried contingency—costs that have been hidden in the details of an estimate to protect a project from the removal of explicit contingency and to ensure that the final project does not go over budget. To reviewers, buried contingency often implies inappropriately inflated quantities, lowered productivity, or other means to increase project costs. Buried contingency should not be used.

Capital assets—

- Land, structures, equipment, systems, and information technology (e.g., hardware, software, and applications) used by the Federal government and having an estimated useful life of 2 years or more. Capital assets include environmental restoration (decontamination and decommissioning) of land to make useful leasehold improvements and land rights, and assets whose ownership is shared by the Federal government with other entities (does not apply to capital assets acquired by state and local governments or other entities through DOE grants). (DOE PM Manual)
- Strategic assets; unique physical or intellectual property that is of long-term or ongoing value to an enterprise; in total cost management, a strategic asset may also include fixed or intangible assets; assets created by the investment of resources through projects (excludes cash and financial assets). (AACE)

Change order—a unilateral requirement signed by the Government contracting officer directing the contractor to make a change that the *changes clause* authorizes without the contractor's consent. (DOE PM Manual)

Code of accounts (COA)—a systematic coding structure for organizing and managing asset, cost, resource, and schedule information; an index to facilitate finding, sorting, compiling, summarizing, and otherwise managing information to which the code is tied. A complete COA includes definitions of the content of each account. (AACE)

Conceptual design—the concept that meets a mission need; requires a mission need as an input. Concepts for meeting a mission need are explored and alternatives considered before arriving at the set of alternatives that are technically viable, affordable, and sustainable. (DOE PM Manual)

Conceptual design report (CDR)—documentation of conceptual design phase outcome; forms the basis for a preliminary baseline.

Construction—a combination of engineering, procurement, erection, installation, assembly, demolition, or fabrication to create a new facility or to alter, add to, rehabilitate, dismantle, or remove an existing facility; includes alteration and repair (dredging, excavating, and painting) of buildings, structures, or other real property and construction, demolition, and excavation conducted as part of environmental restoration or remediation. Construction normally occurs between Critical Decisions 3 and 4 (does not involve the manufacture, production, finishing, construction, alteration, repair, processing, or assembling of items categorized as personal property).

Construction management—a wide range of professional services relating to the management of a project during the pre-design, design, and construction phases; includes development of project strategy, design review of cost and time consequences, value management, budgeting, cost estimating, scheduling, monitoring of cost and schedule trends, procurement, observation to ensure that workmanship and materials comply with plans and specifications, contract administration, labor relations, construction methodology and coordination, and other management of construction acquisition. (DOE PM Manual)

Contingency—

- The portion of a project budget that is available for uncertainty *within the project scope* but outside the scope of the contract. That is, contingency is budget that is not placed on contract. (DOE PM Manual)
- An amount derived from a structured evaluation of identified risks, to cover a likely future event or condition, arising from presently known or unknown causes, within a defined project scope. Contingency is controlled by the government.

Contract—a mutually binding agreement that obligates the seller to provide a specified product and obligates the buyer to pay for it. (DOE PM Manual)

Contract fee—fee earned by the contractor based on dollar value or another unit of measure, such as man hours; an indirect cost.

Contractor—a person, organization, department, division, or company having a contract, agreement, or memorandum of understanding with DOE or another Federal agency.

Control account (or cost account)—the point at which budgets (resource plans) and actual costs are accumulated and compared to earned value for management control purposes; a natural management point for planning and control that represents work assigned to one responsible organizational on one work breakdown structure element. (DOE PM Manual)

Cost accounting—historical reporting of actual and/or committed disbursements (costs and expenditures) on a project. Costs are denoted and segregated within cost codes that are defined in a chart of accounts. In project control practice, cost accounting provides measure of cost commitment and expenditure that can be compared to the measure of physical completion (earned value) of an account. (AACE)

Cost budgeting—allocating the estimated costs to project components. (DOE PM Manual)

Cost control—controlling changes to a project budget and forecast to completion. (DOE PM Manual)

Cost estimate—

- A documented statement of costs to be incurred to complete a project or a defined portion of a project. (DOE PM Manual)
- Input to budget, contract, or project management planning for baselines and changes against which performance may be measured.

Cost estimating—a process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project. As a predictive process, estimating must address risks and uncertainties. The output of estimating is used primarily as input for budgeting, cost or value analysis, decision making in business, asset and project planning, or project cost and schedule control. (AACE)

Critical decision (CD)—a formal determination made by an acquisition executive or designated official at a specific point in a project life cycle that allows the project to proceed. Critical decisions occur at any point in the course of a project (before commencement of conceptual design, at commencement of execution, and at turnover). (DOE PM Manual)

Critical decisions (CDs)—

CD-0, Approve Mission Need

CD-1, Approve Alternative Selection and Cost Range

CD-2, Approve Performance Baseline

CD-3, Approve Construction Start

CD-4, Approve Start of Operations or Project Closeout

Deviation—when the current estimate of a performance, technical, scope, schedule, or cost parameter is not within the threshold value of the performance baseline for that parameter; handled as a deviation, not as part of the normal change control system. (DOE PM Manual)

Direct cost—costs identified with a particular project or activity; includes salaries, travel, equipment, and supplies directly benefiting the project or activity.

Discount rate—the interest rate used in calculating the present value of expected yearly benefits and costs (see definitions for *nominal interest rate* and *real interest rate*). (OMB)

Nominal interest rate—a rate that is not adjusted to remove the effects of actual or expected inflation. Market interest rates are generally nominal interest rates. (OMB)

Real interest rate—a rate that has been adjusted to remove the effect of expected or actual inflation. Real interest rates can be approximated by subtracting the expected or actual inflation rate from a nominal interest rate. A precise estimate can be obtained by dividing 1 plus the nominal interest rate by 1 plus the expected or actual inflation rate, and subtracting 1 from the resulting quotient.) (OMB)

DOE acquisition management system—a systematic method to acquire and deliver a product or capability in response to a program mission or business need; includes facility construction, infrastructure repairs or modifications, systems, production capability, remediate land, closed site, disposal effort, software development, information technology, a space system, research capability, and other assets.

Escalation—cost increases caused by unit price increases. Although project cost can increase because of poor management, scope growth, and schedule delays, escalation is addresses price increases caused by an increase in the cost of labor, material, or equipment necessary to perform the work.

External independent review (EIR)—an assessment mandated by Congress for projects of significant size and complexity; may warrant management attention. (DOE PM Manual)

Facilities—buildings and other structures; their functional systems and equipment; site development features such as landscaping, roads, walks, and parking areas; outside lighting and communications systems; central utility plants; utility supply and distribution systems; and other physical plant features. (DOE PM Manual).

Government estimate—data compiled to estimate what the Government thinks work should cost. A DOE prime site/facility management contract is estimates the cost of sub-contracted work.

Historical cost information—a database of information from completed projects normalized to some standard (geographical, national average, etc.) and time-based (e.g., brought to current year data) using historical cost indices.

Improvements to land—site clearing, grading, drainage, and facilities common to a project as a whole (such as roads, walks, paved areas, fences, guard towers, railroads, port facilities, etc.) but excluding buildings, structures, utilities, special equipment/process systems, and demolition, tunneling, and drilling that are a significant intermediate or end products of the project.

Independent cost estimate (ICE)—a documented, independent detailed, unit-cost, or activity-based cost estimate that serves as a tool to validate, crosscheck, or analyze cost estimates developed by project proponents.

Indirect cost—costs incurred for common or joint objectives which cannot be identified with a particular activity or project.

Inflation—the proportionate rate of change in general price, as opposed to the proportionate increase in a specific price. (OMB)

Information technology (IT) project—one that establishes a system (hardware and/or software) capability to manage information.

Integrated project team (IPT)—a cross-functional group organized to deliver a project to a customer (external or internal). (DOE PM Manual)

Integrated safety management system (ISMS)—A management system designed to ensure that environmental protection and worker and public safety are appropriately addressed in the planning, design, and performance of any task. (DOE PM Manual)

Life cycle—the stages of an object's or endeavor's life. A life cycle presumes a series of beginnings and endings, with each end implying a new beginning. In life-cycle cost or investment analyses, the life cycle is the length of time over which an investment is analyzed. (AACE)

Life-cycle cost—

- The overall estimated cost for a particular program alternative over the time period corresponding to the life of the program, including direct and indirect initial costs plus any periodic or continuing cost of operation and maintenance. (OMB)
- The sum total of the direct, indirect, recurring, nonrecurring, and other costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, support, and final disposition of a major system over its anticipated useful life span. Where system or project planning anticipates the use of existing sites or facilities, restoration, and refurbishment, costs should be included. (DOE PM Manual)

Life-cycle cost analysis (LCCA)—assessment of the direct, indirect, recurring, nonrecurring, and other related costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, support, and final disposition of a major system over its anticipated useful life span.

Line-item project—ones that are specifically reviewed and approved by Congress; a project with total cost greater than \$5 million. (DOE PM Manual)

Major system (MS)—a project or system of projects having a total project cost of \$400 million or greater or designated by the Deputy Secretary as a major system. (DOE PM Manual)

Management reserve (MR)—an amount of a total allocated budget withheld by a contractor for management control (not part of the performance baseline). (DOE PM Manual)

Mission need—a required capability within DOE's overall purpose, scope, cost, and schedule considerations. Mission analysis or studies directed by an executive or legislative authority that identifies a deficiency or an opportunity will be set forth as justification for system acquisition approvals, planning, programming, and budget formulation. (DOE PM Manual)

Net present value (NPV)—the difference between the discounted present values of benefits and costs. (OMB)

Operation—An ongoing endeavor or activity that uses strategic assets for a defined function or purpose. (AACE)

Optimization—a technique that analyzes a system to find the best possible result. Finding an optimum result usually requires evaluating design elements, execution strategies and methods, and other system inputs for effect on cost, schedule, safety, or some other set of outcomes or objectives; employs computer simulation and mathematical modeling. (AACE)

Other project costs—costs for engineering, development, startup, and operations; allowances are essential for project execution, but not part of the normal capital system/facility acquisition cost; funded by operating/expense. (DOE PM Manual)

Performance-based management, contracting, and budgeting—cost and performance tied to quantities, establishing a baseline, and regularly reported to assess performance.

Performance baseline—

- A quantitative expression reflecting the total scope of a project with integrated technical, schedule, and cost elements; the established risk-adjusted, time-phased plan against which the status of resources and the progress of a projects are measured, assessed, and controlled; a Federal commitment to OMB and Congress. Once established, performance baselines are subject to change control. (DOE PM Manual)
- The cost portion of a performance baseline represents a project's total project cost after CD 2.

Preliminary design—continues the design effort using conceptual and project design criteria as bases for project development; develops topographical and subsurface data and determines the requirements and criteria that will govern the definitive design; includes preparation of preliminary planning and engineering studies, preliminary drawings and outline specifications, life-cycle cost analyses, preliminary cost estimates,

and scheduling for project completion. Preliminary design provides identification of long-lead procurement items and analysis of risks associated with continued project development and occurs between CD-1 and CD-2. (DOE PM Manual)

Productivity—consideration for factors that affect the efficiency of construction labor (e.g., location, weather, work space, coordination, schedule); a direct cost.

Program—an organized set of activities directed toward a common purpose or goal undertaken or proposed in support of an assigned mission area and characterized by a strategy for accomplishing a definite objectives, which identifies the means of accomplishment, particularly in quantitative terms, with respect to manpower, materials, and facilities requirements. Programs usually include an element of ongoing activity and are typically made up of technology , projects, and supporting operations. See acquisition program/project. (DOE PM Manual)

Project—a unique effort that supports a program mission, having defined start and end points, undertaken to create a product, facility, or system, and containing interdependent activities planned to meet a common objective or mission. A project is a basic building block in relation to a program that is individually planned, approved, and managed. A project is not constrained to any specific element of the budget structure (e.g., operating expense or plant and capital equipment). Construction, if required, is part of the total project. Authorized, and at least partially appropriated, projects will be divided into two categories: major system projects and other projects. Projects include planning and execution of construction, renovation, modification, environmental restoration, decontamination and decommissioning efforts, and large capital equipment or technology development activities. Tasks that do not include the above elements, such as basic research, grants, ordinary repairs, maintenance of facilities, and operations, are not considered projects. See acquisition program/project. (DOE PM Manual)

Project data sheet (PDS)—a document that summarizes project data and justifies a project as a part of the Departmental budget. PDSs are submitted to request project engineering design and construction funds. Specific instructions on the format and content of PDSs are contained in the annual budget call [DOE O 130.1, *Budget Formulation*, dated 9-29-95]. (DOE PM Manual)

Project engineering and design (PED) funds—design funds established for use on preliminary design, which are operating expense funds. (DOE PM Manual)

Project execution plan (PEP)—the plan which establishes roles and responsibilities and defines how a project will be executed. (DOE PM Manual)

Project life cycle—

- A collection of generally sequential project phases with names and numbers determined by the control needs of the organization or organizations involved in the project. (DOE PM Manual).
- The stages or phases of project progress during the life of a project. Project life-cycle stages typically include ideation, planning, execution, and closure. (AACE).

Project management—a structure in which authority and responsibility for executing a project are vested in a single individual to provide focus on the planning, organizing, directing, controlling, and closing of all activities within a project. (DOE PM Manual)

Project director—A DOE (Federal) project manager who is a project investor, strategist, developer, or contract manager.

Project manager—a contractor manager responsible for day-to-day management of a project and for delivering the means, methods, and resources to meet contract end point requirements and achieve project success.

Project support—activities performed by the operating contractor for internal management and technical support of the project manager.

Range (cost estimate range)—an expected range of costs for a project or its components. Ranges may be established based on a range of alternatives, confidence levels, or expected accuracy, and are dependent on a project's stage of development, size, complexity, and other factors.

Real property—land and/or improvements or interests in them except for land in the public domain. (DOE PM Manual)

Reconciliation—comparison of a current estimate to a previous estimate to ensure that differences between them is appropriate and reasonably expected. A formal reconciliation may include an account of those differences.

Resource—a consumable (other than time) required to accomplish an activity; include real or potential investment in strategic assets including time, money, human, and physical resources. A resource becomes a cost when it is invested or consumed in an activity or project. (AACE)

Review—determination of project or system acquisition conditions based evaluation of project scope, cost, schedule, technical status, and performance in relation to program objectives, approved requirements, and baseline project plans. Reviews provide critical insight into the plans, design, cost, schedule, organization, and other aspects of a project (see definitions for *objective review* and *subject review*).

Objective review—one based on set criteria; a checklist approach to reviewing.

Subjective review—one based on flexible criteria. Management reviews involve criteria and areas that are flexible to reflect management concerns or perceived weaknesses.

Review criteria—components of a review used to reflect the general nature of project (or project element) content.

Risk—a measure of the potential inability to achieve overall project objectives within defined cost, schedule, and technical constraints. Risk components are

- the *probability/likelihood* of failing to achieve a particular outcome, and
- the *consequences/impacts* of failing to achieve that outcome.

Risk management—The act or practice of controlling risk; an organized process that reduces activity or project risks or maximizes the potential for success. (DOE PM Manual)

S-curve (spending curve; funding profile)—

- Graphic display of cumulative costs, labor hours, or other quantities plotted against time. The name is derived from the S-shaped curve (flatter at the beginning and end, steeper in the middle) produced on a project that starts slowly, accelerates, and then slows again. (DOE PM Manual)
- A representation of costs over the life of a project.

Scope—the sum of all that is to be or has been invested in and delivered by an activity or project. In project planning, the scope is usually documented (i.e., the scope document), but it may be verbally or otherwise communicated and relied upon. Generally limited to that which is agreed to by the stakeholders in an activity or project (i.e., if not agreed to, it is out of scope.). In contracting and procurement, scope includes all that an enterprise is contractually committed to perform or deliver. (AACE)

Special equipment—large items of special equipment and process systems, such as vessels, (e.g., towers, reactors, storage tanks), heat transfer systems (e.g., heat exchangers, stacks, cooling towers, de-super-heaters), package units (e.g., waste treatment packages, clarifier packages, sulfurization, demineralization), and process piping systems.

Standard equipment—items which require only a minimum of design; off-the-shelf items (office furniture, laboratory equipment, heavy mobile equipment, and spare parts that are made part of the capital cost); a direct cost.

Start-up—one-time costs incurred during the transition from construction completion to facility operation.

Statement of work (SOW)—a narrative description of contracted products or services. (DOE PM Manual)

Successful project—one that is completed or expected to be completed within the technical, cost, and schedule estimates of the performance baseline.

Total cost management— effective application of professional and technical expertise to plan and control resources, costs, profitability, and risks; a systematic approach to managing cost throughout the life cycle of any enterprise, program, facility, project, product, or service through the application of cost engineering and cost management principles, proven methodologies, and the latest technology in support of the management process. Can also be considered the sum of the practices and processes that an enterprise uses to manage the total life-cycle cost investment in its portfolio of strategic assets. (AACE)

Total estimated cost (TEC)—the specific projected cost of a project, whether funded as an operating expense or construction; includes costs of land and land rights; engineering, design, and inspection; direct and indirect construction; and initial equipment necessary to place the plant or installation in operation, whether funded as an operating expense or construction. In recent years, Congress has authorized funds for projects exclusive of amounts for the construction planning and design. In these cases, the authorized amount is used as a base for TEC, even though it does not include planning and design costs. These costs are typically capitalized. (DOE PM Manual)

Total project cost (TPC)—the cost of the performance baseline, consisting of all costs included in total estimated cost plus other project costs (pre-construction costs, that include conceptual design and research and development) and costs associated with the pre-operational phase (training and start-up); the sum of the technical baseline, schedule baseline, and cost baseline; includes all research and development, operating, plant, and capital equipment costs associated with project construction (sometimes, up to the point of routine operations. (DOE PM Manual)

Trending analysis—systematic tracking of performance against established or planned objectives.

Undistributed budget (UB)—funding associated with specific work scope or contract changes that have not been assigned to a control account or summary level planning package. (DOE PM Manual)

Validation—the process of evaluating project planning, development, baselines, and proposed funding before including a new project or system acquisition in the DOE budget. (DOE PM Manual)

More information on budget validation can be found in the FY2005 Field Budget Handbook, available at

<http://www.cfo.doe.gov/budget/guidance/fy2005/field/Handbook.pdf>.

Value management—an organized effort to analyze the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving essential functions at the lowest life-cycle cost that is consistent with required performance, quality, reliability, and safety. (DOE PM Manual)

Work breakdown structure (WBS)—product-oriented grouping of project elements that organizes and defines the total scope of the project; a multi-level framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. Each descending level represents an increasingly detailed definition of a project component. Components may be products or services. The structure and code that integrate and relate all project work (technical, schedule, and cost) and are used throughout the life cycle of a project to identify and track specific work scope. (DOE PM Manual)

Work package—A task or set of tasks performed within a control account. (DOE PM Manual)

APPENDIX C - SUMMARY OF FEDERAL REQUIREMENTS

This section includes a summary of Federal requirements stemming from Office of Management and Budget (OMB), the Code of Federal Regulations (CFR), Federal Acquisition Regulation (FAR), and Public Laws (P.L.) that drive DOE requirements for cost estimating relative to capital asset acquisitions and real property.

OMB Circular No. A-11, *Preparing, Submitting, and Executing the Budget* (2002), Part 7, Planning, Budgeting, Acquisition, and Management of Capital Assets, provides the framework to guide Federal agencies through the process of formulating a cost-benefit analysis and ultimately the budget submission for Federal agency projects and programs. Major capital investments proposed for funding must—

- support Agency missions
- support work redesign to cut costs and improve efficiency and use of off-the-shelf technology
- be supported by a cost-benefit analysis based on both qualitative and quantitative measures
- integrate work processes and information flows with technology to achieve the strategic goals
- incorporate clear measures to determine not only a project's success, but also its compliance with a security plan
- be acquired through a strategy that allocates the risk between the Government and the contractor and provides for the effective use of contracting
- ensure that the capital plan is operational and supports the Information resource management (IRM) strategic plan

OMB Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 1992), provides an analytical framework for capital planning and investment control for information technology investments. The circular provides the information necessary to complete a thorough review of an IT investment's financial performance. Requirements include—

- evidence of a projected return on investment in the form of reduced cost; increased quality, speed, or flexibility; and improved customer and employee satisfaction
- a cost-benefit analysis for each information system throughout the life cycle that describes
 - level of investment
 - performance measures
 - a consistent methodology with regard to discount rates for cost-benefit analyses of Federal programs

10 CFR 436, Part A, *Methodology and Procedures for Life-Cycle Cost Analysis*, establishes methodology and procedures for estimating and comparing the life-cycle costs of Federal buildings, determining the life-cycle cost effectiveness of energy and water

conservation measures, and rank-ordering life-cycle cost effectiveness measures in order to design a new Federal building or to retrofit an existing Federal building. It also establishes the method by which efficiency shall be considered when entering into or renewing leases of Federal building space.

Chief Financial Officer (CFO) Act of 1990 (P.L. 101-576)

Section 902, a. lists the CFO's regular duties. Among other things, these include:

- Develop and maintain an integrated Agency-accounting and financial management system, including financial reporting and internal controls, which:
 - Complies with applicable accounting principles, standards, and requirements and internal control standards
 - Complies with such policies and requirements as may be prescribed by the Director of OMB
 - Complies with any other requirements applicable to such systems
 - Provides for:
 - Complete, reliable, consistent, and timely information, which is prepared on a uniform basis and which is responsive to the financial information needs of Agency management
 - The development and reporting of cost information
 - The integration of accounting and budgeting information
 - The systematic measurement of performance
- Direct, manage, and provide policy guidance and oversight of Agency financial management personnel, activities, and operations, including:
 - The preparation and annual revision of an Agency plan to (i) implement the 5-year financial management plan prepared by the Director of OMB under section 3512(a)(3) of this title and (ii) comply with the requirements established under sections 3515 and subsections (e) and (f) of section 3521 of this title
 - The development of Agency financial management budgets
 - The recruitment, selection, and training of personnel to carry out Agency financial management functions
 - The approval and management of Agency financial management systems design or enhancement projects
 - The implementation of Agency asset management systems, including systems for cash management, credit management, debt collection, and property and inventory management and control

The CFO Act also set requirements for submission of annual financial statements and annual external audits.

Government Performance and Results Act (GPRA) of 1993, P.L. 103-62, establishes the foundation for budget decision making to achieve strategic goals in order to meet

Agency mission objectives. GPRA provides for the establishment of strategic planning and performance measurement in the Federal government.

GPRA changes the way the Federal government does business, changes the accountability of Federal managers, shifts organizational focus to service quality and customer satisfaction, and improves how information is made available to the public. GPRA states that an organization's mission should drive its activities. Furthermore, GPRA states that the final measure of Federal program effectiveness and efficiency is results, and it requires organizations to measure their results through stated goals. It requires the development of annual performance plans and Agency strategic plans. It requires a return on investment that equals or exceeds those of alternatives.

Federal Managers Financial Integrity Act (FMFIA) of 1982 (P.L. 97-255), as codified in 31 U.S.C. 3512, requires accountability of financial and program managers for financial results of actions taken, control over the Federal government's financial resources, and protection of Federal assets.

Paperwork Reduction Act of 1995 (P.L. 104-13) requires that Agencies perform their information resource management activities in an efficient, effective, and economical manner.

Federal Acquisition Streamlining Act of 199 (P.L. 103-355) requires Agencies to establish cost, schedule, and measurable performance goals for all major acquisition programs and achieve, on average, 90% of those goals. OMB policy for performance-based management is also provided in this section.

Clinger-Cohen Act of 1996 (P.L. 104-208) requires Agencies to use a disciplined capital planning and investment control process to acquire, use, maintain, and dispose of IT. Directs the OMB to establish clear and concise direction regarding investments in major information systems and to enforce that direction through the budget process. The spirit and intent of ITMRA directs Agencies to ensure that IT investments are improving mission performance by—

- establishing goals to improve the efficiency and effectiveness of Agency operations and, as appropriate, the delivery of services to the public through the effective use of information technology
- ensuring that performance measurements assess how effectively the information technology supports programs of the executive agency
- quantitatively benchmarking processes in terms of cost, speed, productivity, and quality of outputs and outcomes where comparable processes and organizations in the public or private sectors exist
- analyzing the missions of each executive agency and, based on the analysis, revising the executive agency's processes as appropriate before making significant investments in information technology
- ensuring that the information security policies, procedures, and practices of the executive agency are adequate

Federal Acquisition Regulation (FAR)

The FAR has many references to cost estimates and cost estimating. Some topics covered by the FAR that should be considered, especially in relation to the procurement or acquisition process, include:

- Acquisition
- Acquisition planning
- Alternate
- Architect-engineering services
- Best value
- Bundling
- Change order
- Claim
- Commercial item
- Component
- Computer software
- Construction
- Contract
- Cost or pricing data
- Cost realism
- Cost sharing
- Design-to-cost
- Final indirect cost rate
- FOB-destination
- FOB-origin
- Forward-pricing rate agreement
- Freight
- General and administrative (G&A) expense
- Indirect cost
- Indirect cost rate
- Information technology
- Inherently Government function
- Inspection
- Insurance
- Major system
- Make-or-buy program
- Market research
- Option
- Overtime
- Overtime premium
- Performance-based contracting
- Pricing
- Residual value
- Task order
- Value engineering
- Value engineering change proposal
- Warranty
- Waste reduction

Cost estimating and related topics can be found in the following sections of the FAR:

- Part 7, Acquisition Planning
- Part 10, Market Research
- Part 14, Sealed Bidding
- Part 15, Contracting by Negotiations
 - 15.4, Contract Pricing - Contains information on proposal analysis, cost and price analysis, technical analysis, and cost realism

-
- 15.402, Pricing policy - Says “Contracting officers must (a) purchase supplies and services from responsible sources at fair and reasonable prices.”
 - 15.407-5, Estimating systems
 - Part 16 - Contract Types
 - 16.4 - Incentive Contracts - Discusses establishing reasonable and attainable targets that are clearly communicated to the contractor and including appropriate incentive arrangements in contracts
 - 16.402-2f - Says “Because performance incentives present complex problems in contract administration, the contracting officer should negotiate them in full coordination with Government engineering and pricing specialists”
 - Part 34 - Major System Acquisitions
 - Part 35 - Research and Development Contracting
 - Part 36 - Construction and Architect-Engineering Contracts
 - Part 37 - Service Contracting
 - Part 42 - Contract Administration and Audit Services
 - Part 43 - Contract Modifications
 - Part 48 - Value Engineering

APPENDIX D - SUMMARY OF DOE REQUIREMENTS

There are at least 38 DOE Orders that reference *cost estimating*. Among them, the primary DOE Orders are:

- DOE O 130.1, *Budget Formulation*, dated 9-29-95, establishes the processes for developing, reviewing, and exchanging budget data. DOE O 130.1 requires that budget formulation be performance based, supportive of the DOE strategic plans, measurable, verifiable, and based on cost estimates deemed reasonable by the program and field offices.
- DOE O 413.3, *Program and Project Management for the Acquisition of Capital Assets*, dated 10-13-00, promotes the systematic acquisition of projects and emphasizes the necessity for managing successful projects. *DOE O 413.3* defines particulars of the CD process: establishing protocol, authorities, and consistency between the DOE programs.
- DOE O 430.1B, *Real Property Asset Management*, dated 9-24-03, establishes a corporate, holistic, and performance-based approach to real property life-cycle asset management that links real property asset planning, programming, budgeting, and evaluation to program mission projections and performance outcomes. The implementation of RPAM maintains requirements for cost estimates and LCCA. RPAM also includes DOE's requirements of the Facilities Information Management System (FIMS) and the Condition Assessment and Information System (CAIS). These systems require cost estimate information concerning replacement plant values (RPVs) and facility maintenance costs.
- DOE O 520.1, *Office of Chief Financial Officer*, dated 1-19-01, promotes the achievement of the objectives of the *CFO Act* (sound financial management policies and practices, effective internal controls, accurate and timely financial information, and well-qualified financial managers) by setting forth the functions, organizational roles, and specific financial management responsibilities of the CFO, the field CFOs, and other appropriate DOE officials.
- DOE O 534.1, *Accounting*, dated 1-6-03, designates the requirements and responsibilities for the accounting and financial management of the DOE. Requirements include, but are not limited to establishing a single, integrated financial management system that serves program management, budgetary, and accounting needs so that DOE and integrated contract records contain sufficient details in accounting for all DOE funds, assets, liabilities, and costs.

APPENDIX E - REVIEW CRITERIA

When reviewing DOE cost estimates, these criteria should be considered a minimum. All criteria should be addressed to be complete, and if all criteria are reasonably addressed, then the estimates represented should be considered reasonable.

Work Breakdown Structure (WBS)

A WBS should be consistent between the technical definition, cost estimate, and schedule. The use of a common WBS should be considered for consistency between projects within a program WBS. Use of a standardized code of accounts is also recommended.

Scope of Work

A scope of work should be commensurate with the planning phase size and complexity of the project and should be activity based to the most practical extent.

Direct and Indirect Costs

All direct costs should be included appropriately, *and* rates applied as percentages—including contract indirect and overhead rates or site indirect rates—should be documented and referenced in the basis of estimate. Indirect rates should be defined for consistent application and appropriate for a given project.

Escalation

Escalation should be included appropriately. The rates applied should be based upon those provided by DOE, or they should have some other documented basis. Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor, etc., due to continuing price changes over time. Escalation is used to estimate the future cost of a project or to bring historical costs to the present.

Contingency

Contingency should be included appropriately, based on apparent project risks or project risk analysis to the most possible extent. In any event, contingency should have a documented basis. Contingency may be calculated using a deterministic or probabilistic approach, but the method employed should be appropriate and documented.

Contingency is an amount included in an estimate to cover costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties. Contingency should also be commensurate with risk—a factor, element, constraint, or course of action in a project that introduces the uncertainty of outcomes and the possibilities of technical deficiencies, inadequate performances, schedule delays, or cost overruns that could impact a Departmental mission. In the evaluation of project risk, the potential impact and the probability of occurrence must be considered.

Contingency is most significant and appropriate for long-term projects and most order of magnitude and preliminary estimate classes with significant size and complexity. Contingency is less significant and appropriate for nearer term projects with less significant size and complexity.

Techniques

Cost estimating techniques employed should be appropriately based on estimate class and purpose, available technical information, time constraints, and compliance with planning and project size and complexity. The chosen techniques should facilitate systematic cost estimate duplication or verification.

Cost Estimate Documentation

Cost estimate documentation should be easily discernable, traceable, and consistent. As a matter of great relative importance, cost estimate documentation should be very thorough (provided to the most possible extent). In most cases, documentation should be specific for a given project (or sub-project) and should be centrally maintained to assure technical/cost/schedule consistency, management focus, and ease of reference.

Cost Estimate Updates

Cost estimate updates should be considered and included, as appropriate, to reflect new information, given a project planning phase and/or execution. Previous versions of cost estimates should be appropriately considered, whether considering information contained in a previous estimate supporting a critical decision, a potential change to a project/contract/budget, or a value engineering study.

Life-Cycle Costs

Life-cycle costs should be appropriately included in estimates. Life-cycle cost estimates are most pertinent during the decision-making phases of a project's life, or when LCC analyses (comparison of life-cycle cost estimates or VE Studies) are performed, but should also be considered throughout a project's life.

Life-cycle costs should include: start-up costs, operating costs, manufacturing costs, machining costs, research and development costs, engineering costs, design costs, equipment costs, construction costs, inspection costs, and decommissioning costs, as well as direct costs, indirect costs, overhead costs, fees, contingency, and escalation costs.

Qualified Cost Estimators

Normally, cost estimators/cost engineers are an important part of an integrated project team. Cost estimates should be performed and documented by those qualified to do so. Professional cost estimators and cost engineers are trained in the use of cost estimating tools, techniques, and all aspects of estimating, project control, and project management.

APPENDIX F - ACQUISITION PROJECT ACTIVITIES AND DELIVERABLES

Table F-1 provides a list of typical activities and deliverables to be considered in the various stages of an acquisition project. Traditionally, color-or-money - capital vs. operating expense, has been a distinguishing factor. This table does not make this distinction, although specific contract/sites/projects/programs may want to make that distinction.

Table F-1. Acquisition Project Activities and Deliverables

ACTIVITIES AND DELIVERABLES
Project Initiation Phase
Establish Project Team
Establish Program/Project Planning Budget
Develop Project Scope
Identify Customer Expectations
Identify Key Schedule Drivers
Identify Funding Constraints
Identify High-Level Functions and Requirements
Identify Project-Level Interfaces
Identify Capital & Life-Cycle Cost Drivers
Develop Pre-Acquisition Design Schedule
Develop Conceptual Design Schedule Range
Develop Market Plan
Develop Pre-Acquisition Design Budget
Develop Up-Front Conceptual Design Business Decision Estimate & Budgets
Establish Placeholder in Out-Year Budget
Initiate Pre-Acquisition Planning and Design
Assess Technology Maturity Phase Plan
Submit CD-0 Package
Develop Project-Level Functions and Requirements
Identify Pre-Acquisition Risks
Perform Alternative/Value Management Studies
Identify Long-Lead or Special Procurement
Establish Conceptual Design Budget & Schedule
Develop Preliminary Design & Schedule Range

ACTIVITIES AND DELIVERABLES	
	Develop Preliminary/Final Design Range
	Develop TPC & Schedule Range
	Preliminary Environmental Strategy
	Identify Current & Next 2 FYs Funding Requirements
	Initiate PDS for Design
	Program Plan
	Mission Need Independent Project Review
	AS in the PASD
	PDS for Design with Special Procurement Disclosure
	Tech Task Request
	Technology Development Issues
Project Planning	
	Perform Project & Phase Technical and Programmatic Risk Analysis
	Develop System-Level Functions & Requirements
	Confirm Long-Lead Procurements
	Develop PEP for Preliminary Design
	Set Project Execution Strategy
	Perform Site Investigation & Alternatives
	Review Design Alternatives/Perform VM
	Identify Project Codes, Standards, & Procedures
	Update Preliminary/Final Design Cost Estimate
	Develop Preliminary Design Phase Budget & Schedule
	Update TPC & Schedule Range
	Perform Safety & Operability Review
	Identify Current & 2 FYs Funding Requirements
	Acquisition Strategy
	Project Expectations Summary
	SOW for Design
	CA/EIS/Record of Decision
	Systems Engineering Management Plan
	Conceptual Design Package
	Preliminary PEP
	Preliminary Hazard Analysis Report

ACTIVITIES AND DELIVERABLES
Preliminary Team Execution Plan
RMP
Preliminary Design Phase Budget and Schedule
Verification of Mission Need
Preliminary Design Package
Updated TPC & Schedule Range
Formal Value Management Plan
Project Baseline
Define Special Procurement
Develop, Validate, & Issue Phased Package, If Necessary
Finalize Permit Requirements
Finalize Team Execution Plan
Commit Critical Equipment
Initiate Pulse Surveys
Perform Process Hazards Review
Select Project Site
Update PEP
Update Technical and Programmatic Risk Analysis
Perform Formal Value Management
Develop Baselines
Develop CD-2 Package
Define CD-3 Deliverables & Completion Criteria
Update Annual/Out-Year Budget Authority
Prepare PDS for Construction
Conduct EIR
Conduct ICR or Estimate
Review of Contractor Project Management System
Preliminary Design Detailed Schedules
Issued for Design Source Documents
Assign Responsibilities Matrix
Performance Metrics
Staffing Plans
Technology Risk Analysis Report
Technology Development Output

ACTIVITIES AND DELIVERABLES	
	Preliminary Safety Analysis Report
	EVMS Certification
	NEPA Documentation
Project Execution	
	Receive Critical Vendor Data
	Finalize 3-D Computer-Aided Drafting and Design Setup
	Complete Design Model
	Conduct Technical Innovations
	Evaluation
	Finalize Planning Drawings
	Finalize Field Support Plan
	Review Safety Action Plan
	Perform Final Design Review
	Equipment and Material Requisitions
	Issue for Construction Design Documents
	100% Definitive Estimate
	Integrated Project Schedule and Sub-tier Schedules
	Updated PEP & Performance Baseline
	Final Design & Procurement Packages
	Verification of Mission Need Budget & Congressional Authorization
	Approved Safety Documentation
	Execution Readiness Independent Review
	Updated Construction PDS
Project Completion	
	Start Site Work
	Complete Procurement of Materials and Equipment
	Start Systems Completion
	Initiate Document Closeout Process
	Work-Off Punch Lists
	Turnover & Startup Plan
	Operating and Maintenance Manuals
	Construction Completion
	Startup Commissioning

ACTIVITIES AND DELIVERABLES
Test Plan
Final Safety Analysis Report
Annual Updates
Construction PDS
Startup/Commissioning
Verification of Testing
Lessons Learned
ORR & Acceptance Report
Approval for Acceptance
As-Built Drawings
Final Safety Report
Project Completion Report

APPENDIX G - EXAMPLE OF THE CALCULATION AND USE OF ESCALATION

Escalation should be used in all estimates where TPC may be impacted due to inflation or increases in unit costs. The following are generic steps in calculating escalation.

Step 1 - Complete cost and Schedule estimates (cost estimate purpose, class, or method does not matter, although it should be organized by the WBS).

Step 2 - Determine midpoint of primary scheduled activities. Typically, an upper-level WBS is necessary to segregate types of activities (e.g., design, construction). It is not necessary to calculate escalation at the lowest levels of activities, since most activities are grouped into logistical WBS elements.

Step 3 - Select Appropriate Escalation Rates. These rates are typically based on information provided by DOE/HQ, but may be based on locally documented information.

Step 4 - Calculate escalation for each scheduled activity by using estimate preparation date as starting point and applying escalation rates selected in Step 3 to midpoint dates determined in Step 2. A straight-line spending curve application may be assumed, although other spending curves may be used, as appropriate.

The following is an example of a 5-year project requiring escalation. Tables G-1 through G-4 represent the steps in calculating escalation. Table G - is an example of a hypothetical project cost estimate summary prior to adding escalation.

Table G -1. Escalation Example - Step 1, Sample Project Cost Estimate Summary

WBS	Scheduled Activity	Total Base Cost (000\$)	Start	Duration (Months)	Complete	Midpoint
A1A	Preliminary Design (Title I Design)	100	10/1/02	6	3/30/03	1/1/03
A1B	Definitive Design (Title II Design)	200	4/1/03	6	9/30/03	7/1/03
A1C	Design During Construction (Title III Design)	100	10/1/03	36	9/30/06	7/1/05
B2A	Equipment Procurement (General Services)	200	10/1/04	24	9/30/06	10/1/05
B2B	Equipment Procurement (Long-Lead, GFE)	2,500	3/30/03	18	9/30/04	1/1/04
B2C	Facility Construction	6,000	10/1/04	37	9/30/06	10/1/05
C1A	Project Management	500	10/1/02	48	9/30/06	10/1/04
C1B	Construction Management	250	10/1/02	48	9/30/06	10/1/04
C1C	Project Support	250	10/1/02	48	9/30/06	10/1/04
	Totals	10,100				

Table G- shows the DOE Escalation Rates (as of January 2002), available through the DOE Budget Formulation Handbook and from the Office of Engineering and Construction Management (ME-90) for projects. Rates used may be different from those provided by DOE, however, there should be a sound basis for escalation rates used.

Table G-2. DOE Escalation Rates (as of January 2002)

FY	Project Categories *									
	Construction		EM		IT		O&M		R&D	
2002	1	N/A	1	N/A	1	N/A	1	N/A	1	N/A
2003	1.021	2.1	1.02	2	1.008	0.8	1.018	1.8	1.023	2.3
2004	1.046	2.5	1.047	2.7	1.017	0.9	1.045	2.6	1.051	2.8
2005	1.076	2.9	1.075	2.7	1.022	0.5	1.073	2.7	1.08	2.7
2006	1.106	2.8	1.103	2.6	1.032	1	1.101	2.6	1.108	2.6
2007	1.135	2.6	1.13	2.4	1.041	0.8	1.127	2.4	1.136	2.5

Table G- is an example of a detailed spread of escalation rates through the applicable fiscal years. This example assumes a straight-line escalation for each FY, although other applications may be appropriate (e.g., all at the beginning or end of a FY). Use of other than straight-line escalation should be well-documented.

Table G-3. Sample Detailed Spread of Escalation Rates

Months of Escalation		0	1	2	3	4	5	6	7	8	9	10	11	12
Month of the Year (Mid-Point)		10	11	12	1	2	3	4	5	6	7	8	9	10
FY	Rate													
2002	2.10%	0.00%	0.17%	0.35%	0.52%	0.70%	0.87%	1.05%	1.22%	1.40%	1.57%	1.75%	1.92%	2.10%
2003	2.10%	2.10%	2.28%	2.46%	2.64%	2.81%	2.99%	3.17%	3.35%	3.53%	3.71%	3.89%	4.07%	4.24%
2004	2.50%	4.24%	4.46%	4.68%	4.90%	5.11%	5.33%	5.55%	5.76%	5.98%	6.20%	6.42%	6.63%	6.85%
2005	2.90%	6.85%	7.11%	7.37%	7.62%	7.88%	8.14%	8.40%	8.66%	8.92%	9.17%	9.43%	9.69%	9.95%
2006	2.80%	9.95%	10.21%	10.46%	10.72%	10.98%	11.23%	11.49%	11.74%	12.00%	12.26%	12.51%	12.77%	13.03%
2007	2.60%	13.03%	13.27%	13.52%	13.76%	14.01%	14.25%	14.50%	14.74%	14.99%	15.23%	15.48%	15.72%	15.97%
2008	2.60%	15.97%	16.22%	16.47%	16.72%	16.97%	17.22%	17.47%	17.72%	17.98%	18.23%	18.48%	18.73%	18.98%

Table G- is an example of the project cost estimate summary with columns added to calculate the escalation per WBS element.

In calculating applicable escalation percentages, repetitive calculations are normal, so a computerized escalation forecast program may prove beneficial. Cash flow may be assumed to be straight-line or based on a spending curve, as appropriate.

It is also necessary to use common sense in applying escalation. For instance, if a construction subcontract is awarded that will cover multiple fiscal years at a competitive fixed-price, it may not be necessary to apply escalation to that contract.

Table G-4. Sample Project Cost Estimate Summary (Including Escalation)

WBS	Scheduled Activity	Total Base Cost (000\$)	Start	Duration (Months)	Complete	Midpoint	Compounded Escalation Rate	Total Escalated Costs (000\$)
A1A	Preliminary Design (Title I Design)	100	10/1/02	6	3/30/03	1/1/03	2.64%	103
A1B	Definitive Design (Title II Design)	200	4/1/03	6	9/30/03	7/1/03	3.71%	207
A1C	Design during Construction (Title III Design)	100	10/1/03	36	9/30/06	7/1/05	9.17%	109
B2A	Equipment Procurement (General Services)	200	10/1/04	24	9/30/06	10/1/05	9.95%	220
B2B	Equipment Procurement (Long-Lead, GFE)	2,500	3/30/03	18	9/30/04	1/1/04	4.90%	2,623
B2C	Facility Construction	6,000	10/1/04	37	9/30/06	10/1/05	9.95%	6,597
C1A	Project Management	500	10/1/02	48	9/30/06	10/1/04	6.85%	534
C1B	Construction Management	250	10/1/02	48	9/30/06	10/1/04	6.85%	267
C1C	Project Support	250	10/1/02	48	9/30/06	10/1/04	6.85%	267
	Totals	10,100						10,927

Once escalation has been applied, it is not normally necessary to reconsider how it is applied. However, in the context of significant changes, for example where schedules change, there may be instances where it is pertinent to consider the impact of escalation to unit costs and hourly labor rates. These types of analyses may become quite complex. Having a systematic approach to estimating escalation will help.



KEY POINT

Cost vs. Obligations - Funding Profile

A funding profile is a normal part of budget submissions. There is a difference between the timing of project costs and obligations and funding requirements. As a project evolves, it should be very clear that funds are required prior to spending them. This lead time should be carefully evaluated and established by the project team. Care should be taken to establish the most appropriate funding profile to provide for efficient use of funds and to minimize carry-over (where funds are not obligated within the FY for which they are authorized).

APPENDIX H - EXAMPLE OF LIFE-CYCLE COST ANALYSIS

OMB A-94 - Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs provides direction in performing cost-benefit analyses, or life-cycle cost analyses (LCCA). Per OMB, LCCAs should always consider all pertinent costs and benefits. Due to the nature of projects considered in fulfilling missions of the DOE, LCCAs may include a component of benefits, which may be depicted as costs to be avoided or saved as a result of a particular alternative. DOE has very few income or revenue streams. However, as a part of life-cycle analyses, all benefits and costs should be recognized, including those that are difficult to quantify (such as benefits to the public or the general economy).

Generally, the steps in performing LCCA are as follows:

- Step 1** - Determine cost estimate summary funding profile for base case and for each alternative case, including all costs and benefits.
- Step 2** - Determine appropriate discount rates to be used. Note discussion on real and nominal discount rates. If escalation is included in the cost estimate summary, use nominal discount rates established by OMB.
- Step 3** - Calculate appropriate discount factors, using the rates determined in Step 2.
- Step 4** - Calculate present-worth (PW) of base case and each alternative case.
- Step 5** - Compare all alternatives and determine the most cost-effective alternative. The lowest PW is the preferred alternative from an economic perspective.

Following is an example that generally shows the steps to be used in performing LCCA.

Step 1 - Determine the cost estimate summary funding profile for the base case and each alternative case being considered, including all costs and benefits. It is important to ensure that similar functions and activities are considered together (e.g., consistent use of a work breakdown structure or account code) to make the scenario as comparable as possible.

Table H- and Table H- and are examples of these summary tables.

Step 2 - Determine appropriate discount rates to be used. If escalation is included in the cost estimate summary, as in this example, use nominal discount rates established by OMB. The following information may also be found in OMB A-94. It is updated biannually.

Nominal Discount Rates - A forecast of nominal or market interest rates for 2003 based on the economic assumptions from the 2004 Budget are presented below. These nominal rates are to be used for discounting nominal flows, which are often encountered in lease-purchase analysis.

Table H-1. Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent)

3-Year	5-Year	7-Year	10-Year	30-Year
3.1	3.6	3.9	4.2	5.1

Real Discount Rates - A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2004 Budget are presented below. These real rates are to be used for discounting real (constant-dollar) flows, as is often required in cost-effective analysis.

**Table H-2. Example LCCA – Step 1
Life-Cycle Cost Estimate Summary, Base Case**

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A1A	Preliminary Design	103	103												
A1B	Definitive Design	207	207												
A1C	Design During Construction	109		37	37	36									
B2A	Equipment Procurement (General Services)	220			110	110									
B2B	Equipment Procurement (Long- Lead, GFE)	2,623	2000	623											
B2C	Facility Construction	6,597		1500	3597	1500									
C1A	Project Management	534	75	175	175	109									
C1B	Construction Management	267	25	100	100	42									
C1C	Project Support	267	25	100	100	42									
E	Contingency (DOE-Held)	86	10	25	25	26									
	Total Project Costs (Escalated)	11,193	2,445	2,560	4,144	1,866	-	-	-	-	-	-	-	-	-
		al													
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
H	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decommissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500										646	662	680	697
	Total Operations (Escalated)	21,392	2,445	2,822	4,682	2,419	568	583	598	613	755	1,420	1,457	1,495	1,534
	Total Life-Cycle Costs (Escalated)	32,585	4,890	5,382	8,826	4,285	568	583	598	613	755	1,420	1,457	1,495	1,534

**Table H-3. Example LCCA – Step 1
Life-Cycle Cost Estimate Summary, Alternative Case**

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A	Design During Construction/Renovation	50	50												
B2A	Procurement/Lease Facility	1,560	102	105	108	111	114	117	120	123	126	129	132	136	139
B2C	Facility Construction/Renovation	6,597		1500	3597	1500									
C1A	Project Management	150	25	50	50	25									
C1B	Construction Management	100	25	50	25										
C1C	Project Support	60	10	40	10										
E	Contingency (DOE-Held)	78	5	5	5	6	6	6	6	6	6	6	7	7	7
	Total Project Costs (Escalated)	11,193	217	1,750	3,795	1,641	119	122	126	129	132	136	139	143	146
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
H	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decommissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500													
	Total Operations (Escalated)	7,693	-	262	538	554	568	583	598	613	755	775	795	816	837
	Total Life-Cycle Costs (Escalated)	18,886	217	2,012	4,334	2,195	687	705	723	742	887	910	934	958	983

Table H-4. Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent)

3-Year	5-Year	7-Year	10-Year	30-Year
1.6	1.9	2.2	2.5	3.2

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than 30 years may use the 30-year interest rate.

Step 3 - Calculate appropriate discount factors, using the appropriate discount rates. The discount factor is calculated as:

$$1/(1 + i)^t$$

where *i* is the discount rate and *t* is the year. For this example, a nominal discount rate is calculated for an ~15-year project, to be ~4.4%. Discount factors are calculated in **Step 4** - Calculate PW of base case and each alternative case using the discount factors calculated in Step 3. Table H- and Table H- are examples of these tables.

Table H-.

Step 4 - Calculate PW of base case and each alternative case using the discount factors calculated in Step 3. Table H- and Table H- are examples of these tables.

Table H-5. Example LCCA – Step 3, Discount Rate Application, Discount Factor Calculation

FY	Consecutive Year	Discount Rate	Discount Factor
2003	1	0.044	0.9579
2004	2	0.044	0.9175
2005	3	0.044	0.8788
2006	4	0.044	0.8418
2007	5	0.044	0.8063
2008	6	0.044	0.7723
2009	7	0.044	0.7398
2010	8	0.044	0.7086
2011	9	0.044	0.6787
2012	10	0.044	0.6501
2013	11	0.044	0.6227
2014	12	0.044	0.5965
2015	13	0.044	0.5713
2016	14	0.044	0.5473
2017	15	0.044	0.5242

**Table H-6. Example LCCA – Step 4
Cost Estimate Summary, Including Present Worth, Base Case**

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A1A	Preliminary Design	103	103												
A1B	Definitive Design	207	207												
A1C	Design During Construction	109		37	37	36									
B2A	Equipment Procurement (General Services)	220			110	110									
B2B	Equipment Procurement (Long-Lead, GFE)	2,623	2000	623											
B2C	Facility Construction	6,597		1500	3597	1500									
C1A	Project Management	534	75	175	175	109									
C1B	Construction Management	267	25	100	100	42									
C1C	Project Support	267	25	100	100	42									
E	Contingency (DOE-Held)	86	10	25	25	26									
	Total Project Costs (Escalated)	11,193	2,445	2,560	4,144	1,866	-	-	-	-	-	-	-	-	-
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
H	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decommissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500										646	662	680	697
	Total Operations (Escalated)	10,378	-	262	538	554	568	583	598	613	755	1,420	1,457	1,495	1,534
	Total Life-Cycle Costs (Escalated)	21,571	2,445	2,822	4,682	2,419	568	583	598	613	755	1,420	1,457	1,495	1,534
				0.9175	0.8788	0.8418	0.8063	0.7723	0.7398	0.7086	0.6787	0.6501	0.6227	0.5965	0.5713
	Discounted Costs (PW)	16,979	2,342	2,589	4,115	2,036	458	450	442	435	513	923	908	892	877

Table H-7. Example LCCA – Step 4
Cost Estimate Summary, Including Present Worth, Alternative Case

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A	Design During Construction/Renovation	50	50												
B2A	Procurement/Lease Facility	1,560	102	105	108	111	114	117	120	123	126	129	132	136	139
B2C	Facility Construction/Renovation	6,597		1500	3597	1500									
C1A	Project Management	150	25	50	50	25									
C1B	Construction Management	100	25	50	25										
C1C	Project Support	60	10	40	10										
E	Contingency (DOE-Held)	78	5	5	5	6	6	6	6	6	6	6	7	7	7
	Total Project Costs (Escalated)	11,193	217	1,750	3,795	1,641	119	122	126	129	132	136	139	143	146
		Annual													
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
H	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decommissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500													
	Total Operations (Escalated)	7,693	-	262	538	554	568	583	598	613	755	775	795	816	837
	Total Life-Cycle Costs (Escalated)	18,886	217	2,012	4,334	2,195	687	705	723	742	887	910	934	958	983
			0.9579	0.9175	0.8788	0.8418	0.8063	0.7723	0.7398	0.7086	0.6787	0.6501	0.6227	0.5965	0.5713
	Discounted Costs (PW)	12,778	208	1,846	3,808	1,847	554	545	535	526	602	592	582	572	562

Step 5 - Compare all alternatives and determine the most cost-effective one. The lowest PW is the preferred alternative, from an economic perspective. Table H-8 shows an example summary of this PW comparison and clearly shows the most cost-effective alternative.

Table H-8. Example LCCA – Step 5, Summary of Base Case and Alternative Discounted Costs, or PW

Activity FY	Base Case	Alt Case
03	2,342	208
04	2,589	1,846
05	4,115	3,808
06	2,036	1,847
07	458	554
08	450	545
09	442	535
10	435	526
11	513	602
12	923	592
13	908	582
14	892	572
15	877	562
PW	16,979	12,778

A standard for life-cycle cost analysis (LCCA) is currently being established by the National Institute for Science and Technology (NIST).

APPENDIX I - BENCHMARKS

The following benchmarks can be found in the text of this *DOE Cost Estimating Guide*. They are included here as a simplified reference. These may be updated periodically. Suggestions or input are appreciated.

Direct Costs

Sources of information include: historical cost information, commercially available databases, vendor “budgetary information,” expert opinion, catalogues and published price lists, GSA schedules, current government contracts, previous cost estimates for similar work, and professional judgment.

Indirect Costs

A summary of site indirect costs can be found at the FMSIC website:
<http://www.mbe.doe.gov/progliaison/fcstrpt/FY01fscr.pdf>

Field Indirect Costs/G&A

Depends on the cost account structure and current local accounting systems employed.

Profit/Fee

Depends on several things, including contract type, etc.

Escalation

Table I-1 contains the current DOE Escalation Rate Table.

**Table I-1. Escalation Rate Assumptions for DOE Projects
(January 2004)**

	Project Categories									
	Construction		EM		IT		O&M		R&D	
FY	Index	%	Index	Rate	Index	Rate	Index	Rate	Index	Rate
2002	1.000	-	1.000	-	1.000	-	1.000	-	1.000	-
2003	1.021	2.1	1.020	2.0	1.008	0.8	1.018	1.8	1.023	2.3
2004	1.046	2.5	1.047	2.7	1.017	0.9	1.045	2.6	1.051	2.8
2005	1.076	2/9	1.075	2.7	1.022	0.5	1.073	2.7	1.080	2.7
2006	1.106	2.8	1.103	2.6	1.032	1.0	1.101	2.6	1.108	2.6
2007	1.135	2.6	1.130	2.4	1.041	0.8	1.127	2.4	1.136	2.5
2008	1.164	2.6	1.157	2.4	1.049	0.8	1.154	2.4	1.164	2.5
2009	1.194	2.6	1.185	2.4	1.057	0.8	1.182	2.4	1.193	2.5

This table can be found at
http://oecm.energy.gov/cost_estimating/2004Rates.pdf

Contingency

Benchmarks for contingency are currently being revised. Note that percentages used in the early stages of a project, should be supported by historical data and statistical simulation to the extent practical. All contingency should be based on a thorough assessment of risks.

Start-Up Costs

Construction start-up costs equal .5%–10% of installed cost of equipment.

APPENDIX J - COST ESTIMATE CLASSIFICATIONS

The following Association for the Advancement of Cost Engineering (AACE) Recommended Practices, No. 17R-97, *Cost Estimate Classification System*, and No. 18R-97, *Cost Estimate Classification System – As Applied in Engineering, Procurement and Construction for the Process Industries*, provide guidance for classifying project cost estimates.

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Cost Estimate Classification System

**PURPOSE**

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to asset project cost estimates. Asset project cost estimates typically involve estimates for capital investment, and exclude operating and life-cycle evaluations. The Cost Estimate Classification System maps the phases and stages of asset cost estimating together with a generic maturity and quality matrix that can be applied across a wide variety of industries.

This guideline and its addenda have been developed in a way that:

- provides common understanding of the concepts involved with classifying project cost estimates, regardless of the type of enterprise or industry the estimates relate to;
- fully defines and correlates the major characteristics used in classifying cost estimates so that enterprises may unambiguously determine how their practices compare to the guidelines;
- uses degree of project definition as the primary characteristic to categorize estimate classes; and
- Reflects generally-accepted practices in the cost engineering profession.

An intent of the guidelines is to improve communication among all of the stakeholders involved with preparing, evaluating, and using project cost estimates. The various parties that use project cost estimates often misinterpret the quality and value of the information available to prepare cost estimates, the various methods employed during the estimating process, the accuracy level expected from estimates, and the level of risk associated with estimates.

This classification guideline is intended to help those involved with project estimates to avoid misinterpretation of the various classes of cost estimates and to avoid their misapplication and misrepresentation. Improving communications about estimate classifications reduces business costs and project cycle times by avoiding inappropriate business and financial decisions, actions, delays, or disputes caused by misunderstandings of cost estimates and what they are expected to represent.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally-acceptable classification system that can be used as a basis to compare against. If an enterprise or organization has not yet formally documented its own estimate classification scheme, then this guideline may provide an acceptable starting point.

INTRODUCTION

An AACE International guideline for cost estimate classification for the process industries was developed in the late 1960s or early 1970s, and a simplified version was adopted as an ANSI Standard Z94.0 in 1972. Those guidelines and standards enjoy reasonably broad acceptance within the engineering and construction communities and within the process industries. This recommended practice guide and its addenda improves upon these standards by:

1. providing a classification method applicable across all industries; and
2. unambiguously identifying, cross-referencing, benchmarking, and empirically evaluating the multiple characteristics related to the class of cost estimate.

Cost Estimate Classification System



This guideline is intended to provide a generic methodology for the classification of project cost estimates in any industry, and will be supplemented with addenda that will provide extensions and additional detail for specific industries.

CLASSIFICATION METHODOLOGY

There are numerous characteristics that can be used to categorize cost estimate types. The most significant of these are degree of project definition, end usage of the estimate, estimating methodology, and the effort and time needed to prepare the estimate. The “primary” characteristic used in this guideline to define the classification category is the degree of project definition. The other characteristics are “secondary.”

Categorizing cost estimates by degree of project definition is in keeping with the AACE International philosophy of Total Cost Management, which is a quality-driven process applied during the entire project life cycle. The discrete levels of project definition used for classifying estimates correspond to the typical phases and gates of evaluation, authorization, and execution often used by project stakeholders during a project life cycle.

Five cost estimate classes have been established. While the level of project definition is a continuous spectrum, it was determined from benchmarking industry practices that three to five discrete categories are commonly used. Five categories are established in this guideline as it is easier to simplify by combining categories than it is to arbitrarily split a standard.

The estimate class designations are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest level of project definition, and a Class 1 estimate is closest to full project definition and maturity. This arbitrary “countdown” approach considers that estimating is a process whereby successive estimates are prepared until a final estimate closes the process.

ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

Notes: [a] If the range index value of “1” represents +10/-5%, then an index value of 10 represents +100/-50%.

[b] If the cost index value of “1” represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Figure 1 – Generic Cost Estimate Classification Matrix

Cost Estimate Classification System

**DEFINITIONS OF COST ESTIMATE CHARACTERISTICS**

The following are brief discussions of the various estimate characteristics used in the estimate classification matrix. For the secondary characteristics, the overall trend of how each characteristic varies with the degree of project definition (the primary characteristic) is provided.

Level of Project Definition (Primary Characteristic)

This characteristic is based upon percent complete of project definition (roughly corresponding to percent complete of engineering). The level of project definition defines maturity or the extent and types of input information available to the estimating process. Such inputs include project scope definition, requirements documents, specifications, project plans, drawings, calculations, learning from past projects, reconnaissance data, and other information that must be developed to define the project. Each industry will have a typical set of deliverables that are used to support the class of estimates used in that industry. The set of deliverables becomes more definitive and complete as the level of project definition (e.g., project engineering) progresses.

End Usage (Secondary Characteristic)

The various classes (or phases) of cost estimates prepared for a project typically have different end uses or purposes. As the level of project definition increases, the end usage of an estimate typically progresses from strategic evaluation and feasibility studies to funding authorization and budgets to project control purposes.

Estimating Methodology (Secondary Characteristic)

Estimating methodologies fall into two broad categories: stochastic and deterministic. In stochastic methods, the independent variable(s) used in the cost estimating algorithms are generally something other than a direct measure of the units of the item being estimated. The cost estimating relationships used in stochastic methods often are somewhat subject to conjecture. With deterministic methods, the independent variable(s) are more or less a definitive measure of the item being estimated. A deterministic methodology is not subject to significant conjecture. As the level of project definition increases, the estimating methodology tends to progress from stochastic to deterministic methods.

Expected Accuracy Range (Secondary Characteristic)

Estimate accuracy range is an indication of the degree to which the final cost outcome for a given project will vary from the estimated cost. Accuracy is traditionally expressed as a +/- percentage range around the point estimate after application of contingency, with a stated level of confidence that the actual cost outcome would fall within this range (+/- measures are a useful simplification, given that actual cost outcomes have different frequency distributions for different types of projects). As the level of project definition increases, the expected accuracy of the estimate tends to improve, as indicated by a tighter +/- range.

Note that in figure 1, the values in the accuracy range column do not represent + or - percentages, but instead represent an index value relative to a best range index value of 1. If, for a particular industry, a Class 1 estimate has an accuracy range of +10/-5 percent, then a Class 5 estimate in that same industry may have an accuracy range of +100/-50 percent.

Effort to Prepare Estimate (Secondary Characteristic)

The level of effort needed to prepare a given estimate is an indication of the cost, time, and resources required. The cost measure of that effort is typically expressed as a percentage of the total project costs

Cost Estimate Classification System



for a given project size. As the level of project definition increases, the amount of effort to prepare an estimate increases, as does its cost relative to the total project cost. The effort to develop the project deliverables is not included in the effort metrics; they only cover the cost to prepare the cost estimate itself.

RELATIONSHIPS AND VARIATIONS OF CHARACTERISTICS

There are a myriad of complex relationships that may be exhibited among the estimate characteristics within the estimate classifications. The overall trend of how the secondary characteristics vary with the level of project definition was provided above. This section explores those trends in more detail. Typically, there are commonalities in the secondary characteristics between one estimate and the next, but in any given situation there may be wide variations in usage, methodology, accuracy, and effort.

The level of project definition is the “driver” of the other characteristics. Typically, all of the secondary characteristics have the level of project definition as a primary determinant. While the other characteristics are important to categorization, they lack complete consensus. For example, one estimator’s “bid” might be another’s “budget.” Characteristics such as “accuracy” and “methodology” can vary markedly from one industry to another, and even from estimator to estimator within a given industry.

Level of Project Definition

Each project (or industry grouping) will have a typical set of deliverables that are used to support a given class of estimate. The availability of these deliverables is directly related to the level of project definition achieved. The variations in the deliverables required for an estimate are too broad to cover in detail here; however, it is important to understand what drives the variations. Each industry group tends to focus on a defining project element that “drives” the estimate maturity level. For instance, chemical industry projects are “process-equipment centric” (i.e., the level of project definition and subsequent estimate maturity level is significantly determined by how well the equipment is defined). Architectural projects tend to be “structure-centric,” software projects tend to be “function-centric,” and so on. Understanding these drivers puts the differences that may appear in the more detailed industry addenda into perspective.

End Usage

While there are common end usages of an estimate among different stakeholders, usage is often relative to the stakeholders’ identity. For instance, an owner company may use a given estimate to support project funding, while a contractor may use the same class of estimate to support a contract bid or tender. It is not at all uncommon to find stakeholders categorizing their estimates by usage-related headings such as “budget,” “study,” or “bid.” Depending on the stakeholders’ perspective and needs, it is important to understand that these may actually be all the same class of estimate (based on the primary characteristic of level of project definition achieved).

Estimating Methodology

As stated previously, estimating methodologies fall into two broad categories: stochastic and deterministic. These broad categories encompass scores of individual methodologies. Stochastic methods often involve simple or complex modeling based on inferred or statistical relationships between costs and programmatic and/or technical parameters. Deterministic methods tend to be straightforward counts or measures of units of items multiplied by known unit costs or factors. It is important to realize that any combination of methods may be found in any given class of estimate. For example, if a stochastic method is known to be suitably accurate, it may be used in place of a deterministic method

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even when there is sufficient input information based on the level of project definition to support a deterministic method. This may be due to the lower level of effort required to prepare an estimate using stochastic methods.

Expected Accuracy Range

The accuracy range of an estimate is dependent upon a number of characteristics of the estimate input information and the estimating process. The extent and the maturity of the input information as measured by percentage completion (and related to level of project definition) is a highly-important determinant of accuracy. However, there are factors besides the available input information that also greatly affect estimate accuracy measures. Primary among these are the state of technology in the project and the quality of reference cost estimating data.

State of technology - technology varies considerably between industries, and thus affects estimate accuracy. The state of technology used here refers primarily to the programmatic or technical uniqueness and complexity of the project. Procedurally, having "full extent and maturity" in the estimate basis deliverables is deceptive if the deliverables are based upon assumptions regarding uncertain technology. For a "first-of-a-kind" project there is a lower level of confidence that the execution of the project will be successful (all else being equal). There is generally a higher confidence for projects that repeat past practices. Projects for which research and development are still under way at the time that the estimate is prepared are particularly subject to low accuracy expectations. The state of technology may have an order of magnitude (10 to 1) effect on the accuracy range.

Quality of reference cost estimating data - accuracy is also dependent on the quality of reference cost data and history. It is possible to have a project with "common practice" in technology, but with little cost history available concerning projects using that technology. In addition, the estimating process typically employs a number of factors to adjust for market conditions, project location, environmental considerations, and other estimate-specific conditions that are often uncertain and difficult to assess. The accuracy of the estimate will be better when verified empirical data and statistics are employed as a basis for the estimating process, rather than assumptions.

In summary, estimate accuracy will generally be correlated with estimate classification (and therefore the level of project definition), all else being equal. However, specific accuracy ranges will typically vary by industry. Also, the accuracy of any given estimate is not fixed or determined by its classification category. Significant variations in accuracy from estimate to estimate are possible if any of the determinants of accuracy, such as technology, quality of reference cost data, quality of the estimating process, and skill and knowledge of the estimator vary. Accuracy is also not necessarily determined by the methodology used or the effort expended. Estimate accuracy must be evaluated on an estimate-by-estimate basis, usually in conjunction with some form of risk analysis process.

Effort to Prepare Estimate

The effort to prepare an estimate is usually determined by the extent of the input information available. The effort will normally increase as the number and complexity of the project definition deliverables that are produced and assessed increase. However, with an efficient estimating methodology on repetitive projects, this relationship may be less defined. For instance, there are combination design/estimating tools in the process industries that can often automate much of the design and estimating process. These tools can often generate Class 3 deliverables and estimates from the most basic input parameters for repetitive-type projects. There may be similar tools in other industry groupings.

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It also should be noted that the estimate preparation costs as a percentage of total project costs will vary inversely with project size in a nonlinear fashion. For a given class of estimate, the preparation cost percentage will decrease as the total project costs increase. Also, at each class of estimate, the preparation costs in different industries will vary markedly. Metrics of estimate preparation costs normally exclude the effort to prepare the defining project deliverables.

ESTIMATE CLASSIFICATION MATRIX

The five estimate classes are presented in figure 1 in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed above.

This generic matrix and guideline provide a high-level estimate classification system that is nonindustry specific. Refer to subsequent addenda for further guidelines that will provide more detailed information for application in specific industries. These will provide additional information, such as input deliverable checklists, to allow meaningful categorization in that industry.

REFERENCES

ANSI Standard Z94.2-1989. **Industrial Engineering Terminology: Cost Engineering.**

Recommended Practice No. 18R-97

Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries



June 15, 1998

PURPOSE

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The Cost Estimate Classification System maps the phases and stages of project cost estimating together with a generic maturity and quality matrix, which can be applied across a wide variety of industries.

This addendum to the generic recommended practice provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the process industries. This addendum supplements the generic recommended practice (17R-97) by providing:

- a section that further defines classification concepts as they apply to the process industries;
- charts that compare existing estimate classification practices in the process industry; and
- a chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic standard, an intent of this addendum is to improve communications among all of the stakeholders involved with preparing, evaluating, and using project cost estimates specifically for the process industries.

It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally acceptable classification system for process industries that can be used as a basis to compare against. It is hoped that this addendum will allow each user to better assess, define, and communicate their processes and standards in the light of generally-accepted cost engineering practice.

INTRODUCTION

For the purposes of this addendum, the term process industries is assumed to include firms involved with the manufacturing and production of chemicals, petrochemicals, and hydrocarbon processing. The common thread among these industries (for the purpose of estimate classification) is their reliance on process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) as primary scope defining documents. These documents are key deliverables in determining the level of project definition, and thus the extent and maturity of estimate input information.

Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this addendum may apply to portions of other industries, such as pharmaceutical, utility, metallurgical, converting, and similar industries. Specific addendums addressing these industries may be developed over time.

This addendum specifically does not address cost estimate classification in nonprocess industries such as commercial building construction, environmental remediation, transportation infrastructure, “dry” processes such as assembly and manufacturing, “soft asset” production such as software development, and similar industries. It also does not specifically address estimates for the exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate

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processing steps in these systems. The cost estimates covered by this addendum are for engineering, procurement, and construction (EPC) work only. It does not cover estimates for the products manufactured by the process facilities, or for research and development work in support of the process industries. This guideline does not cover the significant building construction that may be a part of process plants. Building construction will be covered in a separate addendum.

This guideline reflects generally-accepted cost engineering practices. This addendum was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed by the AACE International Cost Estimating Committee. The practices were found to have significant commonalities that are conveyed in this addendum.

COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

The five estimate classes are presented in figure 1 in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed in the generic standard. The characteristics are typical for the process industries but may vary from application to application.

This matrix and guideline provide an estimate classification system that is specific to the process industries. Refer to the generic standard for a general matrix that is nonindustry specific, or to other addendums for guidelines that will provide more detailed information for application in other specific industries. These will typically provide additional information, such as input deliverable checklists to allow meaningful categorization in those particular industries.

ESTIMATE CLASS	Primary Characteristic	Secondary Characteristic			
	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly.

The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Figure 1. – Cost Estimate Classification Matrix for Process Industries

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CHARACTERISTICS OF THE ESTIMATE CLASSES

The following charts (figures 2a through 2e) provide detailed descriptions of the five estimate classifications as applied in the process industries. They are presented in the order of least-defined estimates to the most-defined estimates. These descriptions include brief discussions of each of the estimate characteristics that define an estimate class.

For each chart, the following information is provided.

- **ANSI Standard Reference (1972) Name:** this is a reference to the equivalent estimate class in the existing ANSI standards.
- **Alternate Estimate Names, Terms, Expressions, Synonyms:** this section provides other commonly used names that an estimate of this class might be known by. These alternate names are not endorsed by this Recommended Practice. The user is cautioned that an alternative name may not always be correlated with the class of estimate as identified in the chart.
- **Description:** a short description of the class of estimate, including a brief listing of the expected estimate inputs based on the level of project definition.
- **Level of Project Definition Required:** expressed as a percent of full definition. For the process industries, this correlates with the percent of engineering and design complete.
- **End Usage:** a short discussion of the possible end usage of this class of estimate.
- **Estimating Methods Used:** a listing of the possible estimating methods that may be employed to develop an estimate of this class.
- **Expected Accuracy Range:** typical variation in low and high ranges after the application of contingency (determined at a 50% level of confidence). Typically, this results in a 90% confidence that the actual cost will fall within the bounds of the low and high ranges.
- **Effort to Prepare:** this section provides a typical level of effort (in hours) to produce a complete estimate for a US\$20,000,000 plant. Estimate preparation effort is highly dependent on project size, project complexity, estimator skills and knowledge, and on the availability of appropriate estimating cost data and tools.

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Class 5 Estimate

ANSI Standard Reference Z94.2-1989 Name:

Order of magnitude estimate (typically -30% to +50%).

Alternate Estimate Names, Terms, Expressions, Synonyms:

Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of-thumb.

Description:

Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended, sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation.

Level of Project Definition Required:

0% to 2% of full project definition.

End Usage:

Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.

Estimating Methods Used:

Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.

Expected Accuracy Range:

Typical accuracy ranges for Class 5 estimates are - 20% to - 50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

Effort to Prepare (for US\$20MM project):

As little as 1 hour or less to perhaps more than 200 hours, depending on the project and the estimating methodology used.

• **Figure 2a. – Class 5 Estimate**

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Class 4 Estimate	
<p>ANSI Standard Reference Z94.2-1989 Name: Budget estimate (typically -15% to + 30%).</p> <p>Alternate Estimate Names, Terms, Expressions, Synonyms: Screening, top-down, feasibility, authorization, factored, pre-design, pre-study.</p> <p>Description: Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 5% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems, and preliminary engineered process and utility equipment lists.</p> <p>Level of Project Definition Required: 1% to 15% of full project definition.</p>	<p>End Usage: Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.</p> <p>Estimating Methods Used: Class 4 estimates virtually always use stochastic estimating methods such as equipment factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling techniques.</p> <p>Expected Accuracy Range: Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.</p> <p>Effort to Prepare (for US\$20MM project): Typically, as little as 20 hours or less to perhaps more than 300 hours, depending on the project and the estimating methodology used.</p>

Figure 2b. – Class 4 Estimate

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Class 3 Estimate	
<p>ANSI Standard Reference Z94.2-1989 Name: Budget estimate (typically -15% to + 30%).</p> <p>Alternate Estimate Names, Terms, Expressions, Synonyms: Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, development, basic engineering phase estimate, target estimate.</p> <p>Description: Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists.</p> <p>Level of Project Definition Required: 10% to 40% of full project definition.</p>	<p>End Usage: Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase “control estimates” against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.</p> <p>Estimating Methods Used: Class 3 estimates usually involve more deterministic estimating methods than stochastic methods. They usually involve a high degree of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project.</p> <p>Expected Accuracy Range: Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.</p> <p>Effort to Prepare (for US\$20MM project): Typically, as little as 150 hours or less to perhaps more than 1,500 hours, depending on the project and the estimating methodology used.</p>

Figure 2c. – Class 3 Estimate

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Class 2 Estimate	
<p>ANSI Standard Reference Z94.2-1989 Name: Definitive estimate (typically -5% to + 15%).</p> <p>Alternate Estimate Names, Terms, Expressions, Synonyms: Detailed control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.</p> <p>Description: Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the "bid" estimate to establish contract value. Typically, engineering is from 30% to 70% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, piping and instrument diagrams, heat and material balances, final plot plan, final layout drawings, complete engineered process and utility equipment lists, single line diagrams for electrical, electrical equipment and motor schedules, vendor quotations, detailed project execution plans, resourcing and work force plans, etc.</p> <p>Level of Project Definition Required: 30% to 70% of full project definition.</p>	<p>End Usage: Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program.</p> <p>Estimating Methods Used: Class 2 estimates always involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tens of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detail takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods.</p> <p>Expected Accuracy Range: Typical accuracy ranges for Class 2 estimates are -5% to 15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.</p> <p>Effort to Prepare (for US\$20MM project): Typically, as little as 300 hours or less to perhaps more than 3,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes.</p>

Figure 2d. – Class 2 Estimate

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Class 1 Estimate	
<p>ANSI Standard Reference Z94.2 Name: Definitive estimate (typically -5% to + 15%).</p> <p>Alternate Estimate Names, Terms, Expressions, Synonyms: Full detail, release, fall-out, tender, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.</p> <p>Description: Class 1 estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans.</p> <p>Level of Project Definition Required: 50% to 100% of full project definition.</p>	<p>End Usage: Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.</p> <p>Estimating Methods Used: Class 1 estimates involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed on only the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities.</p> <p>Expected Accuracy Range: Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.</p> <p>Effort to Prepare (for US\$20MM project): Class 1 estimates require the most effort to create, and as such are generally developed for only selected areas of the project, or for bidding purposes. A complete Class 1 estimate may involve as little as 600 hours or less, to perhaps more than 6,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes.</p>

Figure 2e. – Class 1 Estimate

COMPARISON OF CLASSIFICATION PRACTICES

Figures 3a through 3c provide a comparison of the estimate classification practices of various firms, organizations, and published sources against one another and against the guideline classifications. These tables permits users to benchmark their own classification practices.

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	AACE Classification Standard	ANSI Standard Z94.0	AACE Pre-1972	Association of Cost Engineers (UK) ACostE	Norwegian Project Management Association (NFP)	American Society of Professional Estimators (ASPE)
INCREASING PROJECT DEFINITION	Class 5	Order of Magnitude Estimate -30/+50	Order of Magnitude Estimate	Order of Magnitude Estimate Class IV -30/+30	Concession Estimate	Level 1
					Exploration Estimate	
					Feasibility Estimate	
	Class 4	Budget Estimate -15/+30	Study Estimate	Study Estimate Class III -20/+20	Authorization Estimate	Level 2
	Class 3		Preliminary Estimate		Budget Estimate Class II -10/+10	
	Class 2	Definitive Estimate -5/+15	Definitive Estimate	Definitive Estimate Class I -5/+5	Current Control Estimate	Level 4
	Class 1		Detailed Estimate			Level 5
						Level 6

Figure 3a. – Comparison of Classification Practices

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	AACE Classification Standard	Major Consumer Products Company (Confidential)	Major Oil Company (Confidential)	Major Oil Company (Confidential)	Major Oil Company (Confidential)
 INCREASING PROJECT DEFINITION	Class 5	Class S Strategic Estimate	Class V Order of Magnitude Estimate	Class A Prospect Estimate	Class V
				Class B Evaluation Estimate	
	Class 4	Class 1 Conceptual Estimate	Class IV Screening Estimate	Class C Feasibility Estimate	Class IV
				Class D Development Estimate	
	Class 3	Class 2 Semi-Detailed Estimate	Class III Primary Control Estimate	Class E Preliminary Estimate	Class III
				Class F Master Control Estimate	
	Class 2	Class 3 Detailed Estimate	Class II Master Control Estimate	Class I Current Control Estimate	Class II
	Class 1		Class I Current Control Estimate		

Figure 3b. – Comparison of Classification Practices

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	AACE Classification Standard	J.R. Heizelman, 1988 AACE Transactions [1]	K.T. Yeo, The Cost Engineer, 1989 [2]	Stevens & Davis, 1988 AACE Transactions [3]	P. Behrenbruck, Journal of Petroleum Technology, 1993 [4]
INCREASING PROJECT DEFINITION ↓	Class 5	Class V	Class V Order of Magnitude	Class III*	Order of Magnitude
	Class 4	Class IV	Class IV Factor Estimate	Class II	Study Estimate
	Class 3	Class III	Class III Office Estimate		Budget Estimate
	Class 2	Class II	Class II Definitive Estimate		
	Class 1	Class I	Class I Final Estimate	Class I	Control Estimate

[1] John R. Heizelman, ARCO Oil & Gas Co., 1988 AACE Transactions, Paper V3.7

[2] K.T. Yeo, The Cost Engineer, Vol. 27, No. 6, 1989

[3] Stevens & Davis, BP International Ltd., 1988 AACE Transactions, Paper B4.1 (* Class III is inferred)

[4] Peter Behrenbruck, BHP Petroleum Pty., Ltd., article in Petroleum Technology, August 1993

Figure 3c. – Comparison of Classification Practices**ESTIMATE INPUT CHECKLIST AND MATURITY MATRIX**

Figure 4 maps the extent and maturity of estimate input information (deliverables) against the five estimate classification levels. This is a checklist of basic deliverables found in common practice in the process industries. The maturity level is an approximation of the degree of completion of the deliverable. The degree of completion is indicated by the following letters.

- None (blank): development of the deliverable has not begun.
- Started (s): work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.
- Preliminary (P): work on the deliverable is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
- Complete (C): the deliverable has been reviewed and approved as appropriate.

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		ESTIMATE CLASSIFICATION				
General Project Data:		CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1
Project Scope Description		General	Preliminary	Defined	Defined	Defined
Plant Production/Facility Capacity		Assumed	Preliminary	Defined	Defined	Defined
Plant Location		General	Approximate	Specific	Specific	Specific
Soils & Hydrology		None	Preliminary	Defined	Defined	Defined
Integrated Project Plan		None	Preliminary	Defined	Defined	Defined
Project Master Schedule		None	Preliminary	Defined	Defined	Defined
Escalation Strategy		None	Preliminary	Defined	Defined	Defined
Work Breakdown Structure		None	Preliminary	Defined	Defined	Defined
Project Code of Accounts		None	Preliminary	Defined	Defined	Defined
Contracting Strategy		Assumed	Assumed	Preliminary	Defined	Defined
Engineering Deliverables:						
Block Flow Diagrams		S/P	P/C	C	C	C
Plot Plans			S	P/C	C	C
Process Flow Diagrams (PFDs)			S/P	P/C	C	C
Utility Flow Diagrams (UFDs)			S/P	P/C	C	C
Piping & Instrument Diagrams (P&IDs)			S	P/C	C	C
Heat & Material Balances			S	P/C	C	C
Process Equipment List			S/P	P/C	C	C
Utility Equipment List			S/P	P/C	C	C
Electrical One-Line Drawings			S/P	P/C	C	C
Specifications & Datasheets			S	P/C	C	C
General Equipment Arrangement Drawings			S	P/C	C	C
Spare Parts Listings				S/P	P	C
Mechanical Discipline Drawings				S	P	P/C
Electrical Discipline Drawings				S	P	P/C
Instrumentation/Control System Discipline Drawings				S	P	P/C
Civil/Structural/Site Discipline Drawings				S	P	P/C

Figure 4. – Estimate Input Checklist and Maturity Matrix

REFERENCES

ANSI Standard Z94.2-1989. **Industrial Engineering Terminology: Cost Engineering.**
AACE International Recommended Practice No.17R-97, **Cost Estimate Classification System.**

APPENDIX K - BIBLIOGRAPHY

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